TECHNIQUE OF GASTRECTOMY.

By LEO DOYLE.
Melbourne.

INTRODUCTION.

PRACTICALLY every death after gastrectomy might have been avoided. We know now why patients die and the time has come when, in skilled hands, the mortality rate of gastrectomy done for ulcer compares favourably with that of the disease when treated medically.

The modern surgical operation of gastrectomy is the child of many parents and any attempt to apportion the credit for originality would necessitate an almost never-ending series of acknowledgements. The technical procedure of any one surgeon is the end-result of what he was taught as a student, of what he has later seen or read about, combined with what he has learned from experience. Nevertheless, tribute should be paid to the man who first attempted the operation of gastrectomy. Billroth of Vienna first performed this operation in 1875 using multiple sutures for the anastomosis. Numerous other people have made contributions to the subject, notably Polya, Roux, Hofmeister, Balfour, Finsterer, Roscoe Graham, Phemister and Clark.

Gastrectomy is done for several reasons most of which relate to the presence of a tumour or to some stage of the disease known as peptic ulcer. The type of gastrectomy done should vary according to the disease and to the individual case, but for carcinoma, if at all extensive, practically the whole stomach, certainly the whole of the lesser curvature, should be removed. The rationale of gastrectomy for ulcer is the removal of the ulcer, the ulcer-bearing part of the stomach, and the part which produces the hormone gastrin which is responsible for the stimulation of the fundus to produce the acid peptic juice. This can be achieved by a gastrectomy that removes about 70 per cent. of the stomach including almost the whole of the lesser curvature (Fig. I).
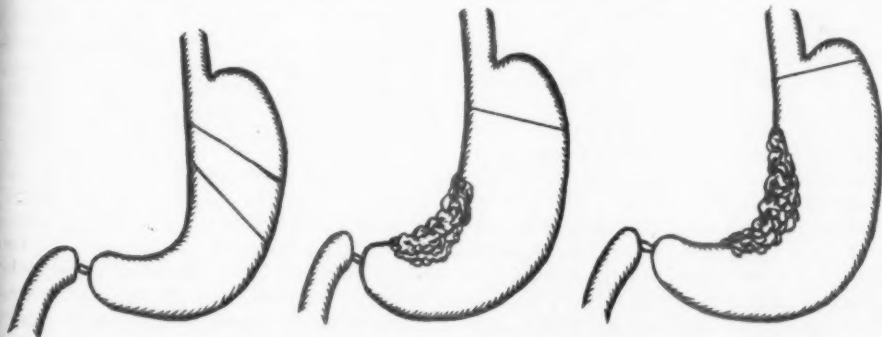

FIG. I. Amount of stomach to be removed in (a) ulcer (b) early carcinoma (c) late carcinoma.

In describing the extent of the operation, the terms partial gastrectomy, sub-total gastrectomy and total gastrectomy are used. Unhappily these names are used loosely and what one man describes as partial gastrectomy is described by another as a sub-total gastrectomy; an operation also described as partial gastrectomy would, by another surgeon, be called pylorectomy. Some men use the term sub-total gastrectomy to describe the removal of half of the stomach and a total gastrectomy for a division through the duodenum, but which leaves a complete oesophagus with more or less stomach attached. I would suggest that if we thought and talked in percentages of stomach removed, nomenclature would be simplified.

PRE-OPERATIVE TREATMENT.

Pre-operative treatment should begin in cases of carcinoma as soon as the diagnosis is made and in cases of peptic ulcer, as soon as the decision to operate has been made. Every endeavour should be made to instil into the patient confidence that the eventual result will be good. The risks of operation should be explained to a patient suffering from a peptic ulcer because his disease is not necessarily fatal but these should not be emphasized to a patient suffering from carcinoma.

When the decision to operate has been made the patient's physical reserves should be estimated. These can best be evaluated by ascertaining the body weight and the red cell count, haemoglobin content, plasma proteins and plasma chlorides of the blood. If possible the correct volume of the blood should also be ascertained. When a deficiency is shown to be present it will probably be of the red cells, of the plasma protein or of the chlorides and efforts should be made by means of high protein, high calorie and high vitamin diets as well as by transfusions of blood, plasma or saline to make the patient as fit as possible for operation. The mixture of skim-milk powder, milk, glucose, etc., known as Varcoe's No. 2 diet is very useful because it can be given by intragastric drip when the patient is unwilling or unable to drink the required quantity. The patient should be transfused steadily until the haemoglobin value of his blood is between 90 and 100 per cent.; this is better

done with repeated small transfusions than with a large one. Because repeated transfusions may be required it is essential that the Rh factor be known and taken into consideration. Chlorides should be estimated and, if low, they should be built up; salt can be given intravenously or by mouth until the urine shows the presence of salt. Great care should be exercised when a patient has a high haemoglobin value and a low chloride one because he is probably very dehydrated and will require a lot of careful management before he is ready for operation. Unless a surgeon is well versed in resuscitation measures he will be wise to have skilled help with a patient of this type. If a patient is nervous or apprehensive a sedative mixture can be of great help in the pre-operative phase. Should there be any cardiac disease or disease of other parts of the body, e.g., diabetes, nephritis, etc., it should be brought under control if possible and its existence considered when planning what type of anaesthesia is to be used.

It is customary to advise that the stomach should be washed out before operation. I think this is wrong because not only is the process unpleasant but also because it is useless. It is useless because if there is no gross retention the stomach will be empty and if there is gross retention the stomach will contain much material which will not pass through a stomach tube. If gross retention is present the best way of emptying the stomach is to make the patient take a large quantity of water and then induce vomiting by the use of an emetic. After this, only fluids should be given by mouth until operation.

All patients should be operated on under an antibiotic screen and any vitamin deficiencies made good, if necessary, by hypodermic injection.

ANAESTHESIA.

Adequate pre-operative treatment and correct and skilful anaesthesia are the two most important factors in achieving success with the operation of gastrectomy. I have always disliked ether anaesthesia and, when I first abandoned it, used local anaesthesia and would do so again if occasion demanded. Next, I used high spinal anaesthesia with nupercaine 1:1500 but found that it did not

give me enough time to do a careful and adequate operation. I now use either continuous spinal analgesia with novocaine given with the Tuohy intra-dural catheter or controlled respiration anaesthesia obtained by the use of pentothal, cyclopropane and curare.

I do not use spinal analgesia if there is any possibility of having to open the chest. This, of course, means that I use it solely for patients with ulcer because I believe that a surgeon should always be prepared to open the chest if he wishes to eradicate completely a gastric carcinoma.

chest need seldom be opened, but as any attack on a carcinoma may involve a total gastrectomy the approach and anaesthesia should be designed so that a thoracotomy is possible. Any carcinoma of the body or fundus should be attacked through the chest or through a thoraco-abdominal incision.

THE ABDOMINAL APPROACH.

Rutherford Morrison, many years ago, is reputed to have said that there are only two incisions in the abdomen; either straight up and down in the midline or straight across anywhere else. I believe that this statement is practically correct. There are (Fig. II)
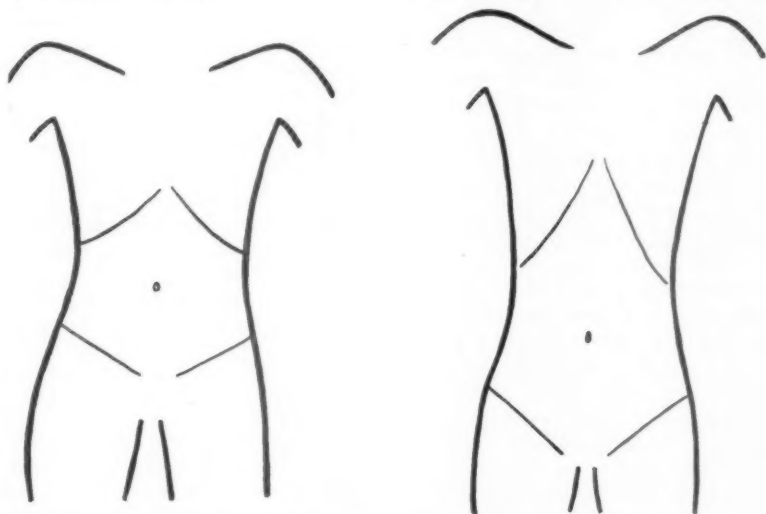

FIG. II. Different types of abdomen. (a) short and broad. (b) long and narrow.

With the superior anaesthesia available to-day I doubt whether any gastrectomy should be done with ether, given by the open method, as the anaesthetic agent. The operation is seldom so urgent that it cannot be deferred until an anaesthetist skilled in the more modern methods is available.

THE APPROACH TO THE STOMACH.

This is determined by 1. the lesion.

                2. the site of the lesion.

                3. the shape of the chest.

Briefly, a gastrectomy done for a peptic ulcer, will be done in the abdomen and the

two extreme types of thoracic cage:— the "tight laced," wasp-waisted, visceroptotic type that has a very acute subcostal angle and carries its liver and stomach very low in the abdomen, and the barrel-chested type with the wide open costal angle whose viscera are situated high under the diaphragm and it must be obvious that the one incision will not be correct for both types. In doing a gastrectomy for ulcer in the first type, a midline incision will probably give the best access, but in the second type a transverse incision gives a better exposure. For the numerous intermediate types the surgeon must use his discretion, leaning generally to the transverse incision. In making this

transverse incision an attempt should be made to go between the intercostal nerves (Fig. III). Fear of the rectus muscle failing
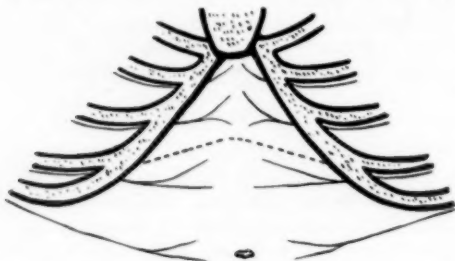
FIG. III. Illustrates the direction of intercostal nerves on the abdominal wall.

to heal with the consequent production of a hernia has, I think, kept many from the transverse incision. Experience has now taught me that the rectus heals very well and leaves no abdominal weakness. I think the right and left paramedian incisions are bad, no matter whether the rectus muscle is split or turned out. They are associated with the division, across the direction of its tension, of the transversus abdominis muscle, a muscle which plays a most important part in the mechanics of the belly, and this is done for the sake of avoiding injury to the rectus muscle, an unimportant factor. In operating for ulcer a left paramedian incision gives a reasonable approach to the left gastric artery and to a high ulcer, but the poor access it gives to the duodenum has been responsible for many exclusion operations. The right paramedian incision on the other hand, whilst it exposes the duodenum adequately, makes it very difficult to ligate the left gastric artery, and to divide the lesser curvature at a reasonably high level.

In addition to having adequate relaxation provided by correct anaesthesia I find that I can maintain the exposure thus provided by making full use of a Devine retractor. It will not only hold the abdominal walls apart, but the mechanical hands can be used to hold the viscera and intestines back out of the way. However, should the attack be made across the chest, a Tudor Edwards rib spreader provides a better exposure. It fits round the curve of the chest and lies nicely in position.

When the abdomen has been opened the next step depends on the type of the disease for which the operation is being done.

CARCINOMA.

Every gastric carcinoma for its cure requires a gastrectomy which is planned to remove the effected part with a very wide margin. It is also necessary to remove as much as possible of the lymphatic gland distribution and, in advanced cases, to extend the removal to affected adjacent organs. The existence of liver metastases would contra-indicate operation on a non-obstructing carcinoma of the cardia, but would not be a contra-indication to operation on an obstructing carcinoma of the pylorus or antrum. Liver metastases sometimes take a long time to kill, and, if any possibility of temporary relief to the patient can be seen, a gastrectomy should be done. I do not consider that a total gastrectomy should be done in the presence of metastases, but it might be possible to short-circuit the stomach by the method of Allison (1946). Livingstone and Pack (1940) have said that, despite our improved methods, the mortality of radical resection is not decreasing. They attribute this to the fact that surgeons are now much bolder and not only are they doing resections where formerly they did not, but they are also making these resections much more radical. This is not a futile beating of wings because the future of any resectable case is not always predictable. I have had patients live six and seven years after a resection which was apparently a forlorn hope.

The same author (Pack, 1940) shows that the best final figures in gastric carcinoma come from clinics which have a high operation mortality—20-25 per cent., but whose resectability rate is also high. A low mortality rate for resection usually means a low resectability rate. I do not wish to stress the obvious, but there is a 100 per cent. mortality in the non-resected cases, and it is quite probable that the man with the high resectability rate, despite his high operative mortality will have a better eventual survival rate than his more conservative colleague. In the surgery of carcinoma of the stomach there should be no room for the conservative nor for the pessimistic

surgeon, nor for the one who is operating with an eye on his statistics, nor, need I say, for the surgeon who is in a hurry. With modern anaesthetic and resuscitation methods it is possible to operate for many hours without causing the patient to be shocked, and I think advantage should be taken of this state of affairs.

ULCER.

If there is a diagnosis of pyloric obstruction or hour-glass stomach, or if an ulcer has been disclosed by the laparotomy, there can be no hesitation about going on with the operation, but, if operating for pain or bleeding and finding no obvious ulcer, it may take a little courage to proceed with the operation. One has only to remove the apparently normal stomach of a patient with severe haematemesis to find on opening it, that there is a small soft ulcer, with an open spouting vessel in its centre, a lesion that no finger could feel, to have no doubt about one's course of action on a future similar occasion. I think it impossible to open a stomach and empty it of clot and be sure, after inspecting what is visible of its interior, that there is not an ulcer of this type present. An ulcer of the second part of the duodenum c a n be overlooked (probably because its possibility is not remembered) and be the cause of further symptoms. To open an apparently normal stomach to find that there is an advanced antral gastritis with small ulcers on the lesser curvature also gives one courage to act on the pre-operative diagnosis. On occasion, such a stomach will be found to be the site of a gastritis, but to have no sign of an ulcer. The surgeon should not be discouraged, the patient will be relieved.

Tanner (1948) has recently discussed this subject and states that a gastritis can be the only demonstrable lesion in a patient who has bled severely. I have seen severe pain relieved by the removal of a stomach which had a gastritis but no ulcer. Operating on these patients is like operating on a kidney with a diagnosis of early tuberculosis or tumour—one has to be prepared to remove the organ despite its appearance of normality.

TECHNIQUE OF REMOVAL OF THE STOMACH.

Before beginning a description of the actual technique a few general details are appropriate. An intravenous needle is always in place, preferably placed by a direct stab into an arm vein, but if this is not possible or advisable, the internal saphenous vein is opened at the ankle. If the pre-operative preparation has been prolonged and difficult, advantage may be taken of this opportunity to give the last preparatory pint of blood, but otherwise normal saline or Ringer's solution is run through the needle. A pint of blood of the correct group which has been cross-typed should always be available, and if the patient has been very sick or it is expected that the operation will be long and difficult, two or more pints should be available.

When the anaesthetic has been given the patient should be placed in the correct position. If the approach is to be thoracoabdominal the patient should be placed half on his right side and held by sandbags placed under his scapula and under his buttock. The left arm and left leg may be placed across the body thus helping to hold him in position. Should it be the operator's intention to approach through the ribs, the patient should lie on his right side and his left arm should hang down on the right side of the table or be fixed to an anaesthetic screen. The surgeon should personally superintend and actually help to place the patient in the correct position before he gowns and gloves himself. In this way he can be sure that the position of the patient is as he wants it.

I do not use clamps at all times, nor do I use straight needles. I have found that suturing with straight needles is difficult if the stomach and duodenum are divided at the correct level. I use the diathermic cutting and coagulating currents to cut across the viscus and to produce haemostasis. If this is not available a scalpel can be used for the division and haemostats for clamping the vessels, or the vessels can be under-run with a needle and cotton and tied before division. I prefer the diathermic coagulation method for its convenience and easy efficiency.

Carcinoma.

The extent of the excision of a carcinoma should include the lesion and a generous margin, and this may require doing a total gastrectomy, and perhaps removing all or part of adjacent organs. However, all the requirements of a surgical removal are not capable of a routinely planned attack—the disease varies in its extent, the anatomy varies and the surgeon must do what he can. If the lesion is situated near the pylorus and of such extent that no feats of surgical derring-do are required, the attack is commenced by lifting the great omentum out of the incision and stripping it off the transverse colon. As a rule this is simply done by holding up the omentum and breaking into the tissue plane on the anterior surface of the colon. Only a few vessels need be ligated. This stripping is carried over as close to the pylorus as possible and then across at the other side to the gastrosplenic omentum. When this step is completed the lesser omentum is broken through and the first part of the duodenum is then exposed for further preparation by holding the stomach up out of the wound. When plainly identifiable, the right gastric artery is doubly ligated with strong (No. 2) silk and divided between the ligatures. This step frees the first part of the duodenum to a greater extent and facilitates its further clearance, and its division. Where the duodenum is easily freed the division is simple, but if difficult, one of the many methods devised for this manoeuvre may be utilized, or it may be necessary for the surgeon to devise one for the occasion.

Ulcer.

In operating for ulcer it is sufficient to divide the gastro-colic omentum below the arterial arcade and to carry this division as far to the left as thought necessary. If this division is carried almost to the place where the gastro-colic omentum becomes the gastro-splenic omentum and if the gastro-hepatic omentum has been divided at approximately the level where the left gastric artery comes on to the stomach, and the organ cut across between these two points, about 70 per cent. of the stomach will have been removed. As the lesser sac is opened towards the right side it will be found that

its posterior wall is adherent to the stomach. This attachment is easily freed by putting the parts on tension and cutting with the scissors in the bloodless line; by so doing the duodenum and the right gastro-epiploic artery are made more accessible. At this stage a sharp look out must be kept for the middle colic artery as it runs very close to the stomach and can be damaged very easily. The stomach and first part of the duodenum are gradually freed. This may be quite easily done if there is no disease there, but in the case of a duodenal ulcer it may be difficult or even impossible. If the surgeon finds that the removal of the duodenal ulcer is beyond his technical ability, he should do a division proximal to it. If this division is across the duodenum he need not worry about not removing the ulcer, but should it be proximal to the pyloric sphincter he must be quite sure that he then removes every trace of mucosa in the remaining gastric remnant. I think that this manoeuvre should not be adopted lightly, but that a conscientious attempt should be made to make the line of division across the duodenum.

In closing the distal end which is usually the duodenum, one has to be quite sure that no pyloric mucosa has been left, for, if it has, the secretion of peptic juice will not cease. The pyloric vein makes a very good surgical landmark, and no gastric mucosa will be left behind if the division is made distal to it. In operating for duodenal ulcer this is not always quite easy, but even under these circumstances an attempt should be made to free the duodenum sufficiently far to give an amount of normal tissue that will make closure easy and certain. In doing this, care must be taken to avoid damage to the common bile duct. In a case where there is any doubt about the possibility of this structure being endangered, Lahey (1943) advises that it be opened in the free edge of the gastro-hepatic omentum, and then its location, in regard to the ulcer, determined definitely, by passing a probe or a stiff rubber tube along it.

The principle to be adopted in the duodenal closure is apposition of the serosal surfaces and the avoiding of eversion of the mucosa (Fig. IV). Serosa to serosa is
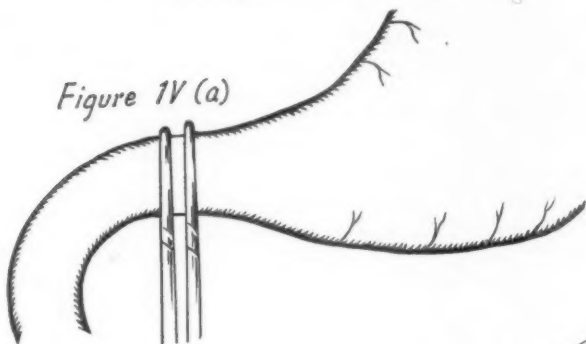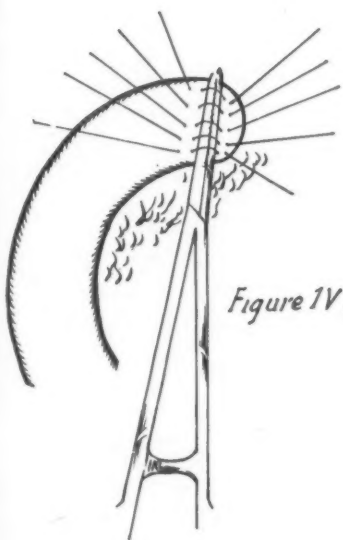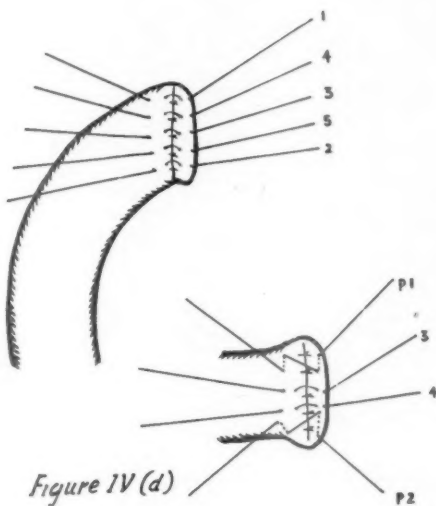
Figure 1V (a)

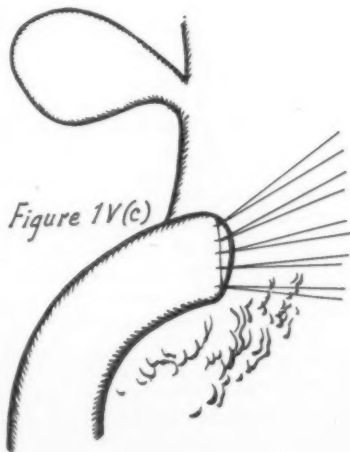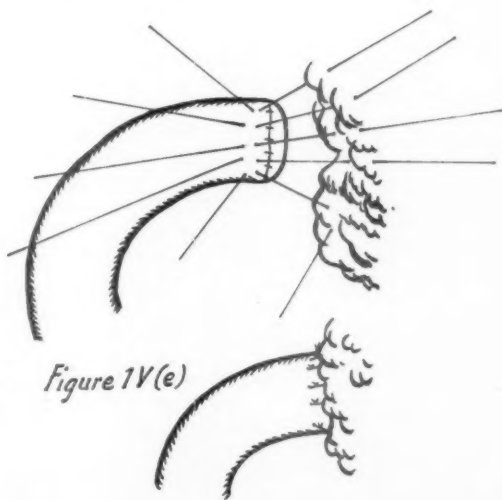Figure 1V (b)

Figure 1V (c)

Figure 1V (d)

Figure 1V (e)

FIG. IV. Method of closing the duodenum.

not always possible if the duodenum is divided, as its posterior wall is mostly a non-peritoneal structure. However, if the external walls are inverted by two layers of interrupted, non-absorbable sutures, and if the peritoneum of the anterior wall of the duodenum is stitched to the peritoneum of the pancreas or of the posterior abdominal wall and the suture line also covered by any available tags of omentum, closure will be satisfactory. In stitching the peritoneum of the post abdominal wall care must be taken to avoid the gastro-duodenal artery, which is quite big and lies just below the peritoneum. Sometimes the suturing is easy but sometimes it is difficult and a satisfactory closure taxes the ingenuity of the surgeon. I believe that any attempt to suture the mucosa not only wastes time, but also may make the serosal suture more difficult by producing everted portions of mucosa which are difficult to persuade inside the external suture lines. It is also important to remember that the blood supply of the duodenum has the same pattern as the rest of the small bowel (Shapiro and Robilliard, 1946). It consists of branches of the pancreatico-duodenal artery which run at right angles to the bowel wall and which supply only a small part of the bowel. Any anastomosis between such adjacent arteries occurs only in the small vessels, and so will supply only a very short portion of adjoining bowel wall.

While doing a duodenal closure it is wise to remember that a duodenal blow-cut is a commonly reported and occasionally fatal accident. It is perhaps comforting at this stage to remember also, that no amount of accurate suturing will hold a duodenal closure intact, if pressure develops in the proximal loop, owing to kinking at the proximal end of the gastro-jejunostomy.

Ligation of Left Gastric Artery.

The duodenum having been divided and closed the proximal end of the stomach is wrapped in a pack and pulled out and over the left costal margin. At this stage it is a good procedure to put a pack over the pancreas and try with a mechanical hand to pull it into a lower position in the abdomen. If this can be done, the stomach is put on the stretch and this usually makes the left gastric artery and coronary vein easily visible.

This manoeuvre can be assisted by putting a Deaver's retractor on the posterior wall of the stomach near where the artery comes on to it (Fig. V) and thus putting the gastro-pancreatic ligament on the stretch. The

FIG. V. The exposure of the left gastric artery.

stomach may need some freeing from the posterior abdominal wall to make this possible. The artery and vein are now usually plainly visible and may be tied separately or together, and also now is the opportunity in a case of carcinoma to remove any visible glands in this region. Two further ties should now be placed in order to control the collateral circulation on the lesser curvature, one below the arterial tie and one above it. The lesser omentum can now be divided down on to the stomach wall. As in this part the peritoneum separates early as it passes to the anterior and posterior walls it leaves a rather large bare area of smooth muscle on the lesser curvature. The correct line for the transverse division of the stomach is now visible and any vessels passing to or from this area should be ligated or coagulated. A sucker is then passed into the stomach from duodenal opening and all gastric fluid and air evacuated.

Division of Stomach.

The ends of the line of division having been visualized, Allis forceps are placed on the greater and lesser curvatures just proximal to this line and the stomach divided with the cutting current or with a scalpel. An attempt is made to make the first cut through the muscle layers only, so that the blood vessels running in the sub-mucosa become visible and can be coagulated or ligated. In this fashion, it is sometimes possible to cut the viscus across and have practically no bleeding. Should there be any bleeding it can nearly always be controlled by the coagulating current and rarely requires a haemostat. It is advisable to make the muscle cut completely around the stomach before cutting across the mucosa. When the first opening is made into the mucosa the sucker is again used to evacuate any fluid that may have been left in the fundus. The stomach is then cut completely across with
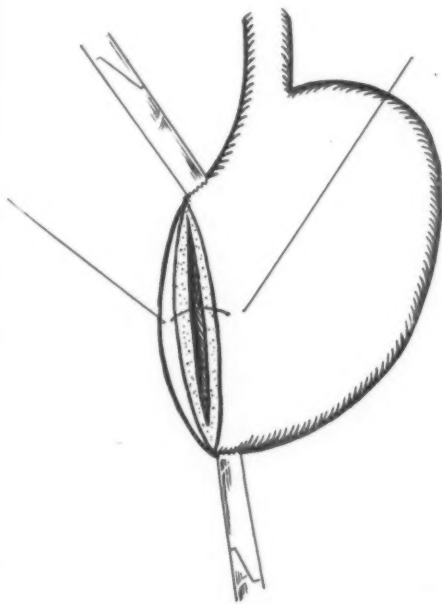

FIG. VI.

the cutting current. While moderate tension is kept on the Allis forceps, which are holding the greater and lesser curvatures of the stomach (Fig. VI), a stitch is passed to

mark the division of the cut stomach into two parts, viz.; that part which is to be closed and which will form the Hofmeister valve and that part which will form the gastro-jejunostomy.

It is now opportune to discuss how large this gastro-jejunostomy opening should be, and it should be remembered that no matter how large the size of the stoma it cannot pass any more food in unit time than the jejunum is capable of taking through its lumen, i.e., the effective size of the opening cannot be greater than the size of the lumen of the jejunum. This is, of course, not the actual size of the stoma which is usually made equal to 2/3 of the width of the cut end of the stomach. Now with this in mind, it will be found that a stitch at the junction of the upper and middle thirds or the upper 3/8 and lower 5/8 of the cut end of the stomach will mark out a stoma of an adequate size, one probably equal to one or two times the diameter of the jejunum. It should be remembered that if the stomach is very dilated the opening should be larger than need be made in a stomach of normal size, because of the shrinkage that will occur when the stomach assumes its correct size. The selected spot is marked with a Lembert stitch passing through from the anterior to posterior surfaces of the stomach (Fig. VI), or vice versa. At this point I would reiterate my opinion that suture of the mucosa is difficult and unnecessary. I make suture lines between the peritoneal surfaces only, and make them with one layer of interrupted non-absorbable sutures using for preference Coats 40 black cotton (the black colour being helpful as aid to visibility). These sutures take in the serosa with, of course, a backing of muscle, and produce quick adhesion between the two serous sutures. The mucous layer is inverted in such a fashion that the two submucous layers lie against each other and soon unite. The excess of mucosa over muscle will force the submucous layers into apposition when the serous and muscle layers are stitched. When the marking suture has been passed, Allis forceps on the lesser curvature side are removed and the portion of the cut surface from the marker up to the lesser curvature is closed (Fig. VII). This is done simply
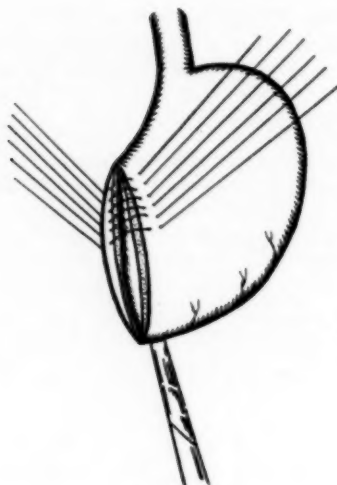
FIG. VII.

by passing a series of Lembert sutures about
4 to 5 mm. apart and making sure that there
is serosal approximation as far as the peri-
toneum of the gastro-pancreatic fold through
which the left gastric artery ran (Fig. VIII).
There is no need whatsoever to suture the
mucosa. I have not sutured the mucosa for
at least three years and am quite definite
that time spent in doing so is worse than
wasted, because, frequently, endeavours to
suture this membrane succeed only in pro-
ducing an eversion of it. Layers of intestinal
epithelium will not heal when opposed to
each other any more than will skin. The
sewn mucosa will also stick up and get in
the way, and so make a peritoneal approxi-
mation difficult but, if not stitched, it will
never do this.

It is now necessary to decide which type
of gastro-jejunostomy is to be used to restore
the continuity of the alimentary tract. For
different reasons at different times various
people have advocated various types of
junction.

Billroth's first operation (Fig. IX), done
in 1875, was done by partly closing the
cut end of the stomach and doing a gastro-
duodenostomy. This operation, with various
modifications, has been done at intervals
since. It is constantly being revived for
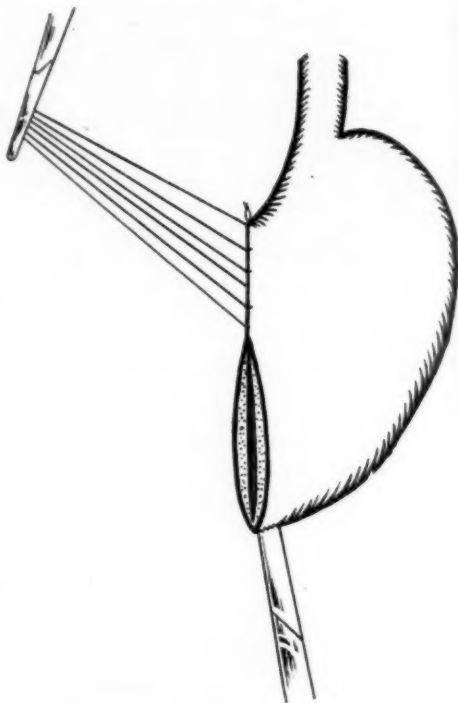awhile and then being dropped again. It

FIG. VIII.

has the great advantage that all the operat-
ing is done above the transverse mesocolon
and that the suturing done to close the duo-
denum forms part of the reconstitution of
the alimentary canal, but it has some dis-
advantages. First, the suture line at the
gastro-duodenostomy is circular, and cica-
tricial contraction leads to stenosis. For this
complication I have had to undo one case
and then do the usual type of operation, and
another patient is having the same form of
trouble after this operation. Secondly, it
may tempt the surgeon to leave enough
stomach to ensure the anastomosis being
done without tension, and thus occasion the
leaving of too much stomach. Billroth's
No. 2 operation (Fig. IX), in which both the
duodenum and the cut end of the stomach
were closed and continuity restored by a
gastro-jejunostomy was not done very ex-
tensively. Billroth's anastomosis was ante-
colic and differed in this respect from that
of Mikulicz, done in 1889, whose anastomosis
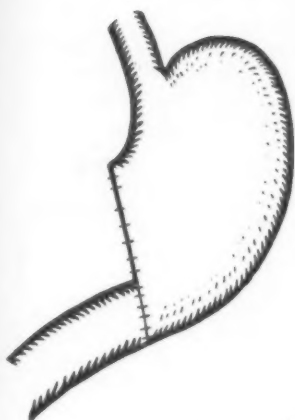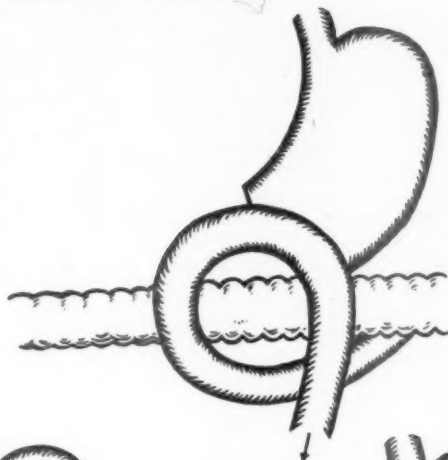was done behind the colon.

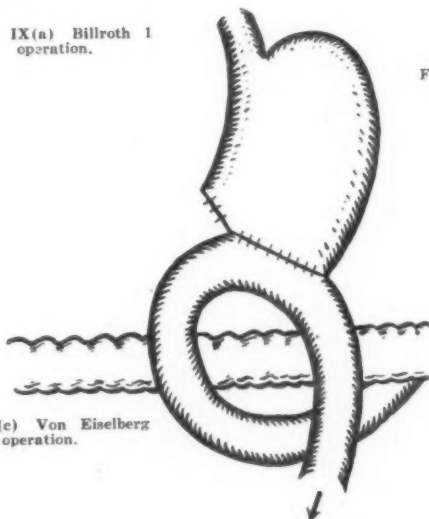FIG. IX(a) Billroth 1 operation.

FIG. IX(b) Billroth 2 operation.

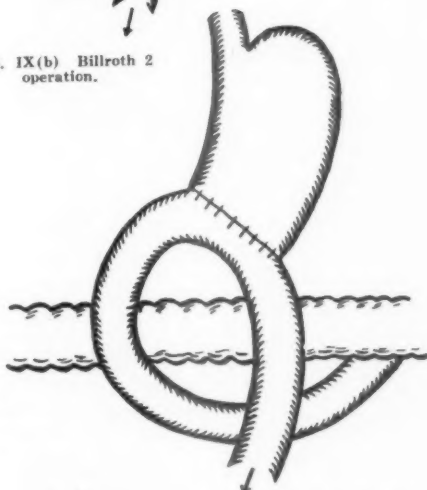FIG. IX(c) Von Eiselberg operation.

FIG. IX(d) Kronlein-Balfour operation.

FIG. IX(e) Moynihan operation.

FIG. IX(f) Polya operation.

The next variation was the use of the cut end of the stomach and its suture to the jejunum. This was first done by Von Eiselberg in 1889 (Fig. IX). He used an ante-colic iso-peristaltic anastomosis using only a part of the cut end of the stomach. Hofmeister, in 1908, and Finsterer (1905), did the same, but used a retro-colic anastomosis.

Kronlein, in 1887, (Fig. IX) did an ante-colic iso-peristaltic anastomosis using the whole of the cut end of the stomach as the stoma. This was rediscovered by 1916 by Balfour. Moynihan, in 1922, varied the process (Fig. IX). He used the same stoma but made the direction anti-peristaltic, i.e., the efferent loop to the lesser curvature. I did this on a couple of occasions but there was trouble in the convalescence. Polya, in 1911 (Fig. IX), used a whole end anastomosis, but made it iso-peristaltic and retrocolic and this anastomosis was used extensively until recent years.

For some years now I have used a variation of the Kronlein-Balfour technique. The variation consisting of closing as I have just described the upper or the lesser curvature third of the stomach opening and using the lower or greater curvature two thirds as the stoma. The jejunum, however, has been stitched to the whole length of the cut surface, the lesser curvature 1/3 being, of course, closed. This stitching of jejunum to the closed stomach creates a valve which is called the Hofmeister valve.

Wangensteen (1945) is certain that, unless the union is a no-loop, iso-peristaltic and retro-colic one, there will be trouble in the shape of gastro-jejunal ulcer. Before I had heard of this, I had done so many ante-colic gastro-jejunostomies that I knew that he was not completely right. Also I am unable to see how the surgeon can take a structure which normally lies below the pancreas and suture it to a structure that lies above the pancreas and leave no loop, unless something is kinked or stretched. If he leaves no loop his Hofmeister valve must be incomplete or he takes the chance of later kinking at the proximal jejuno-gastric junction. This is very dangerous because one of the common

accidents, after gastrectomy is a blow-out of the duodenal stump. I believe, with Maclure (1940), that obstruction at the proximal jejuno-gastric junction (Fig. X)

FIG. X. To illustrate how kinking at the proximal end cf the gastro-jejunostomy causes obstruction of the afferent loop.

with consequent dilation of the afferent jejunal loop is a more likely cause of this accident than is poor suturing of the duodenum itself, and a loop that is too short helps to create such a kink. An ante-colic iso-peristaltic anastomosis, leaving sufficient loop to ensure no kinking at the proximal jejuno-gastric junction, has several advantages. First, it is easy to do. Secondly, the colon is not a continual source of obstruction. Thirdly, should there be any post-operative trouble requiring a re-opening, it is easy to approach, and, fourthly as said above, care can be taken to see that there is no kinking either at the proximal or distal ends of the gastro-jejunal opening.

I quite realize that my series of cases cannot compare with those produced in the U.S.A. and is statistically valueless, but I have done enough to be sure in my mind that there is no reasonable ground for expecting trouble with this type of anastomosis.

The pack and the mechanical hand that has been holding the colon down are loosened and the first loop of the jejunum brought forward (the only way one can be sure that the loop is the first, is to see the duodeno-jejunal flexure). When quite sure that the position is correct the anti-mesenteric border of the bowel is fixed to the two
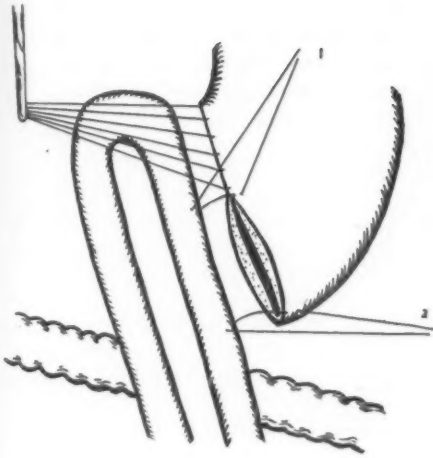
FIG. XI.

ends of the stoma by cotton sutures (Fig. XI) in such a fashion that there is definitely no tension in the proximal loop. The sutures are left long and are used as fixation sutures. In a properly done operation they will constitute the end sutures of both the anterior and posterior rows of the anastomosis.

In selecting the part that is to be joined to the stomach the afferent loop is left long enough to allow the colon plenty of room, and is of such a length that there is always sufficient bowel to allow it to unroll itself should a kink occur.
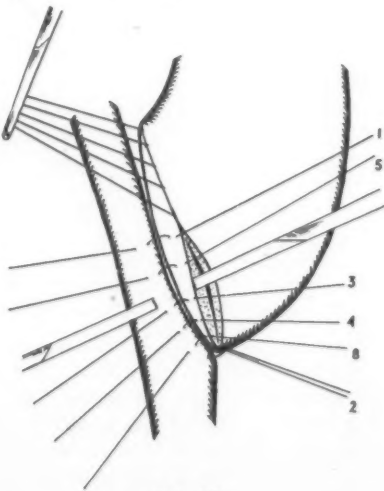
Allis clamps are now used to expose the posterior surface of the stomach and another to mark the anti-mesenteric border of the jejunum. With the posterior surfaces of both viscera exposed the suturing is commenced (Fig. XII). A Lembert suture is passed from the middle of the posterior wall of the stomach to the middle of a line lying a few mm. behind the anti-mesenteric border of the jejunum. Imaginary lines are now marked out joining this spot to the two fixation sutures at the ends of the proposed opening and these lines, so marked out, are now joined together. Care at this time is taken to ensure no kinking or cobbling of either the proximal or distal ends of the gastro-jejunal stoma. This is done by passing sutures in such a fashion that they bisect any space where there is not a suture.

The first bisecting suture has already been passed; the next two bisect the spaces between this middle suture and the two ends. The fourths so marked out are again bisected and so on until enough sutures have been passed to ensure adequate approximation.
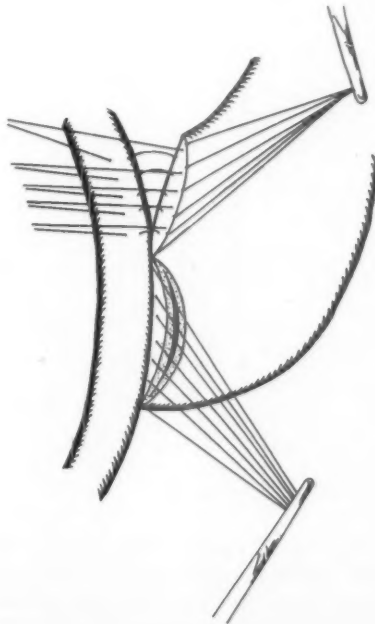

FIG. XII.

FIG. XIII.

This suturing is easier if the stitches are all passed and held before any are tied. When tied, these sutures are used to make traction in a downward direction on the stomach (Fig. XIII) and advantage is taken of this opportunity to stitch the jejunum to the posterior

FIG. XIV.

FIG. XV.

on the stoma, except the two end ones, are cut, but those on the Hofmeister end are left to be used later on as tractors. The jejunum is now opened along the anti-mesenteric border opposite to the gastric stoma and for a length equal to it. Any bleeding, which will probably be trivial, can be controlled by coagulation, or sutures. The same technique is used again, i.e., the first stitch of the anterior surface is passed from the middle of the anterior surface of the stomach to the middle of the anterior wall of the jejunal stoma (Fig. XV). Once again the process of bisection is adopted until an adequate number of stitches has been passed. These are tied and it will be found that the top and bottom fixation stitches bear their correct relation to
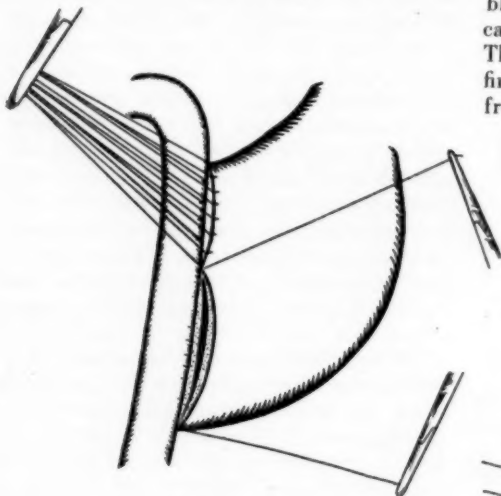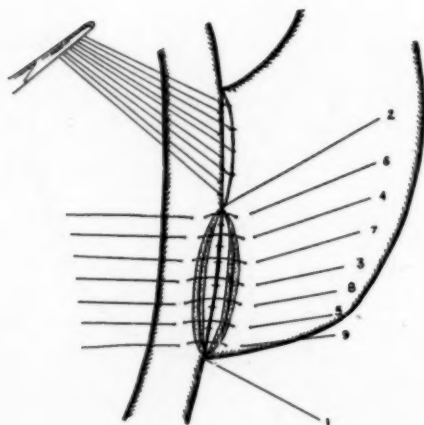
FIG. XVI.

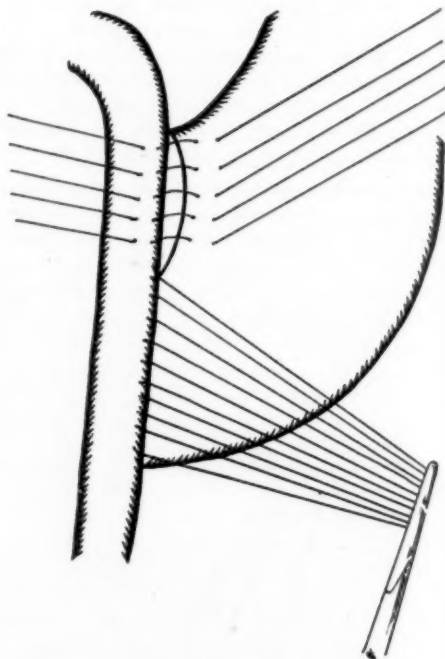part of the Hofmeister valve closure. This suture continues the posterior suture between jejunum and stomach up to the lesser curvature behind the closed opening of the stomach. When this is complete the sutures

both the anterior and posterior line of sutures. Before cutting, these stitches are clamped and used as a tractor to help in suturing the jejunum to the anterior layer of the Hofmeister valve (Fig. XVI). When

all the sutures are passed, tied and cut, and the stomach has been returned to the abdomen, care is taken to see that the efferent loop runs straight away from the stomach —for 6-9 inches at least.

If a very high gastrectomy has been done for carcinoma of the stomach and there is any danger of kinking at the proximal gastro-jejunostomy, it is a good idea to make a jejuno-jejunostomy between the afferent and efferent loops.

Before the abdomen is closed it is necessary to ensure that the afferent loop is not kinked at the proximal gastro-jejunal junction and that the efferent loop leads away in a straight line for 6-9 inches from the stomach.

The gall-bladder may now be removed if it is diseased. Cholecystectomy makes a very trifling addition to the operation, and may save trouble later on. It has not been my custom to explore the lower abdomen with an idea of removing the appendix. If easy, perhaps it should be done, but if difficult it certainly should not be done. The operation area is inspected and any small pools of blood removed with a sucker exploring all the nooks and crannies where such a small collection can hide, especially Morrison's pouch and alongside the spleen.

The question of drainage will occasionally arise, generally where there has been much oozing and perhaps a large ulcer bed left behind. I have noticed that patients who come to operation after they have been transfused extensively for haematemesis, bleed very freely at operation. However, the large majority of cases do not require a drain, but should one be needed I would suggest that it be passed through a separate stab wound. This has the double advantage of not obstructing the actual suturing of the wound and of not risking the transfer of infection into the wound. In closing the wound I sew the posterior sheath with the peritoneum and then the anterior sheath, each with a continuous suture of stainless steel wire of S.W. gauge 32. This method works very well, and I have on occasion had

a mildly infected wound heal up around such a continuous steel suture, and leave no sinus. I consider the method to be safe and effective. Since using it I have not had a wound rupture and have had very little infection, none of it serious, but this, of course, may be only coincidence. The method also gives one greater confidence in permitting very early ambulation.

Carcinoma of the Cardiac End.

Carcinoma of the cardiac end presents a completely different problem to carcinoma of the body or of the pylorus. Whilst with a lesion in these latter situations it may be reasonable to explore through the abdomen, this is definitely not so with the high carcinoma, and probably also not so in cases of carcinoma of the body, as an adequate removal of either of these two lesions will probably require an almost total gastrectomy. I have now formed the opinion that any carcinoma in which it is thought that the resection will be very extensive, is better exposed by the trans-thoracic route. The exploration should be through the 8th or 9th rib bed, opening the pleural cavity first and incising the diaphragm radially from the hiatus to the costal margin at the location of the excised rib. The fundus of the stomach now lies in the wound and the spleen usually presents. The tumour should now be examined to see its extent, and it is surprising how frequently it is found to have invaded the oesophagus. However, the crucial spot which will probably determine the operability of the tumour is the region of the left gastric artery. If this is so involved by tumour that it cannot be ligated, it is no use attempting to proceed further. The inspection, to determine this, is best made by opening the gastro-colic and gastro-splenic omenta, and lifting the stomach forward. If, after inspection, it is decided to go ahead, the next steps depend on the downward extent of the lesion, and if this is at all extensive, a total gastrectomy will be necessary. If the lesion at the cardiac end is small it may be possible to save enough stomach so as to make possible an oesophago-gastrostomy.

Total Gastrectomy.

The steps are the same as for a partial gastrectomy, but the division of the omenta proceeds right around both curvatures. In tying the vasa brevia, great care should be exercised, as they are very short vessels and a ligature, unless accurately tied, can easily slip off and allow severe bleeding. It is probably wise to remove the spleen, as by doing so, considerable working room is gained. To complete the preparation of the stomach at its distal end, it may be necessary to cut across the costal margin and to continue the incision into the abdominal wall. When the duodenum has been cut across and closed, the freed stomach is pulled upwards and outwards and the oesophagus freed until sufficient of it is available to allow division at an adequate distance above the lesion. This division is not made immediately but the stomach is used as a tractor until the anastomosis of the type described by Roscoe Graham (1940, 1943) has been done to the stage where it is safe to divide the oesophagus.

The Roux type of anastomosis has been described by some writers, and recently in this connection Reynolds and Young (1949) have made some interesting observations on the first branch of the superior mesenteric artery. I have performed a Roux operation but once and my patient died, and I have not used it since. Some authors have described an oesophago-duodenostomy and recently Priestley and Kumpuris (1948) of the Mayo clinic have reported some cases. I have not attempted the method, but think it might tempt one to skimp on the oesophageal division. It is a simpler anastomosis if it can be done without tension. One is inclined to discount it but should remember that it has been done by reputable surgeons.

Partial Gastrectomy with Oesophago-Gastrostomy.

Should it be found on examining the tumour that it can be excised adequately and a reasonable quantity of stomach left, this is a satisfactory operation (Reynolds and Young, 1949). The first step will be to free

the oesophageal end and probably remove the spleen. The gastro-colic omentum is then divided in such a fashion that on the right side the gastro-epiploic arterial arcade is left intact. The left gastric artery is divided, but care is taken to keep the right gastric artery and its arcades intact. The stomach is then divided at the correct level below the tumour, preserving as much as is possible and reasonable of the greater curvature. The cut end of the stomach is partly closed with a single layer of interrupted cotton serosal sutures, leaving opening enough for the oesophago-gastrostomy stoma. The upper end of the stomach is used as a tractor to pull the oesophagus down as far as possible. The greater curvature of the distal portion of the stomach is pulled up and its posterior part sutured to the oesophagus with interrupted cotton sutures. The posterior surface of the oesophagus is now opened, and the adjacent layers of the two organs are sewn together with interrupted whole thickness sutures of chromic catgut. The oesophagus is now completely divided and the tumour removed. The anterior layer of whole thickness catgut sutures is now made and the anastomosis completed by one or two or more layers of interrupted cotton sutures. This anastomosis will lie in the thorax and the stomach should be stitched to chest wall or diaphragm or both, so as to take any tension from the suture line. In passing I would like to say that, owing to its denervation, the residue of the stomach will probably develop a retention which I have not found to be serious.

The diaphragm is now sutured with a continuous suture of 32 gauge steel wire, and the wound closed with more continuous sutures of steel wire. I have found that, if the ribs above and below the excised one are held together temporarily a continuous suture between the intercostal muscles will hold the space closed without any pericostal sutures.

The remaining layers of the chest are closed with continuous steel sutures and the same is used for the skin. I have used drainage in the chest and given it up, started

to drain again, and now I am in a "no-drainage" phase. Drainage requires suction and care, and I lost one patient because his chest was blown up.

From the way I have spoken I hope it will not be thought that I consider carcinoma in this region to be a very hopeful lesion. Unless the lesion blocks the cardiac orifice and produces obstructive symptoms at an early stage it will probably grow very far, until, by the time the diagnosis is made, the tumour is incurable. It is a treacherous tumour because, even when symptoms are available to indicate its presence, it is frequently missed by the radiologist, even though he is looking for it.

AFTER TREATMENT.

I now have the patient X-rayed on the second or third post-operative day and if there is any fluid in the chest it is aspirated. This is simply done and can be repeated if necessary.

If the pre-operative treatment of a partial gastrectomy, the anaesthetic, and the operative procedure have been along sound lines, the post-operative period is usually devoid of any trouble. Pain is relieved by morphine or a derivative, and thirst by fluid given at first intravenously, and later by the rectal route. Nothing is given by mouth for an arbitrary period of four days. It is my belief, founded on some experience, that the stomach behaves much as the other hollow viscera in the abdomen and will, after handling, become paralysed for a few days. I believe that if food is given during this period it may simply lie in the atonic viscus and act as a source of discomfort and lead to air swallowing with perhaps vomiting and hiccups. I like to have an indwelling tube passed before operation and, after operation, it is attached to a suction apparatus of the syphon type. In this manner neither air nor fluid is allowed to lie in the stomach. On the fourth or fifth post-operative day permission is given for water to be drunk, on the sixth day milk, and from then on the diet is built up rapidly until, by the tenth day, he is having a good diet.

Where the anastomosis has concerned the oesophagus I like the diet to be fluid for about a week, and then very soft for another week. If any remnant of the stomach has been left it allows earlier feeding. When an extensive gastrectomy has been done it is well to point out to the patient that he has a very small stomach which will hold only small quantities of food, and that he will be wise to eat often of small quantities, rather than attempt big meals.

A patient who has had a total gastrectomy or a very extensive gastrectomy may suffer with diarrhoea during the post-operative period. This can be treated with bismuth and opium and by giving hydrochloric acid. It is also important to remember that this complication can result in the loss of a great amount of fluid and salt and that these must be replaced. In my absence I lost a patient because this was not appreciated. They are also said to be liable to macrocytic anaemia. I have had only one such case which developed 8 years after an extensive gastrectomy for carcinoma. No attention is paid to the bowels unless they have failed to act in a week. An enema is then given. Occasionally in a very sick patient, who has been dehydrated, a faecal impaction may occur, but this can be relieved very easily and is a very small price to pay for the freedom from trouble experienced by the majority of patients.

Rising.

The patient is persuaded to move about in bed and encouraged to sit up. As soon as he can sit up without assistance it is pointed out to him that there is no difference between sitting up in bed and sitting in a chair, and that, in fact, the chair would be more comfortable. In this way he is persuaded out of bed and very soon learns to walk.

I cannot conclude without a few words on the post-operative complication called "dumping stomach." The characteristics of this are sensations of discomfort which may amount almost to pain, which are associated with shivering, giddiness and sweats, and which come on after a variable but usually fairly short period following food. Some

years back, when I tried treating a few cases of intractable peptic ulcer by jejunostomy feeding, I found that if a big feed was given straight away the patient had a symptom complex that resembled the above. If the feeds were given slowly by a drip no such thing happened. Now a similarly quick filling of the jejunum can happen after a gastrectomy, particularly if the whole end of stomach constitutes the stoma (Fig. XVII) and particularly if the efferent gastro-jejunal opening has been strictured by over-suturing. If this has occurred it is easy to see how the stomach could fill up and then by its efforts to empty itself distend that portion of the jejunum that is sutured to it, and then finally force its contents rapidly into the jejunum distending it also. Emphasis is given to this argument by the fact that some dumping stomachs, which had occurred in patients whose gastro-jejunal opening comprised the whole of the cut end
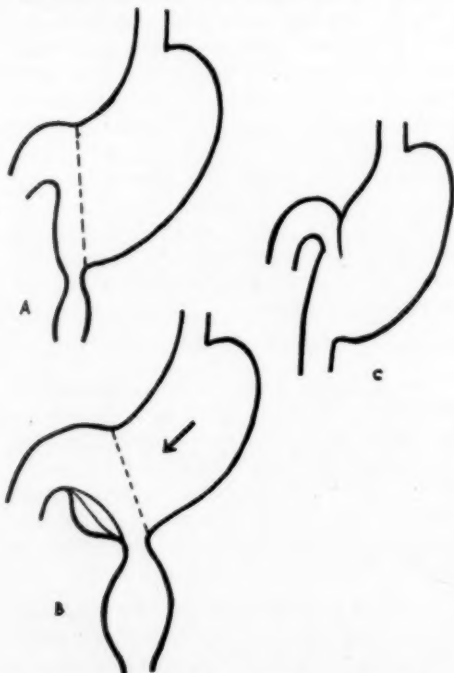

FIG. XVII. To illustrate how a stomach "dumps" its contents.

of the stomach have been relieved by re-doing the anastomosis with a Hofmeister valve which allows only smaller portions of stomach content to enter the jejunum. I attribute my patients freedom from this complication to the facts that, first, I am extremely careful not to diminish or distort in any way the distal gastro-jejunal opening and second, I always make a Hofmeister valve. The food leaves the stomach quickly as there is no distortion or stenosis of the efferent jejunal opening, and as it does not accumulate there it cannot be "dumped" into the jejunum. I am aware that this explanation is not acceptable to all surgeons, but I offer it for what it is worth.

MORTALITY.

A paper like this would be incomplete without some mention of the mortality incurred. I have tried to glean some information of value from the deaths, but this is not easy. The practical point in a mortality ratio is its value in assessing to the patient, who requires such an operation, the risk to be incurred. This is made difficult by three constantly varying factors:— The patient, the disease, and the surgeon. In the otherwise healthy patient who is being operated on for intractable pain, but who is not suffering any deficiencies there will be only an accidental mortality, provided the surgeon has a complete knowledge of the correct technique and sufficient skill to employ it. On the other hand the elderly sick patient suffering from avitaminosis, inanition, dehydration, and anaemia, and depressed by long continued pain and vomiting will present a difficult problem for any surgical team. Again the patient, suffering from haematemesis, whose operation is a last desperate throw made to stave off an imminent disaster, will be very fortunate if he does not die. In dissecting my own mortality rate I have thought that, as surgical practice has so altered in the past few years, the consideration of deaths that occurred before this era would convey no useful lesson, and so I have confined the figures to the five year period—1944-1948. I have been unable to separate them into the various grades of risk and so can present only the figures obtained by a consideration of the whole group. I have performed, in this period, 122 gastrectomies for ulcer with a total mortality

of 11 cases (9 per cent.). An interesting subdivision, however, is into that of public hospital and private patients of which the numbers are equal but the deaths are not. There were 60 gastrectomies in private patients with 3 deaths (5 per cent.) and 62 public hospital cases with 8 deaths (12.9 per cent.). For some unknown reason in 1946 out of 13 public cases there were 5 deaths. If we exclude this year we get 49 operations with 3 deaths, a rate which approximates to the private one. The desperate haematemesis risks are included in the both series, and some of these were almost certain disasters before the operation was started. There were some, but not so many cases of haematemesis amongst the private series. The age in some of the cases was sometimes great — the eldest being a woman of 80 who recovered easily. I have not gone over the age incidence but it would be well over forty, as I operate on very few young patients. The private series of 60 cases with 3 deaths might easily have been better. The first to die was a middle-aged Greek, whose high spinal anaesthetic was not good enough, and an ether supplement was required. This he took very badly, and he was a very difficult operative problem. I think he died of a badly done operation, the result of poor anaesthesia. The next death was another anaesthetic one. He was aged 60, and a high spinal anaesthetic wore off near the end of the operation. He was given intravenous pentothal as a supplement and it had to be repeated. He then stopped breathing, and his heart stopped beating. Artificial respiration was done and the heart massaged through the diaphragm. It was a long time before it started again, but it eventually did. However, he never really recovered consciousness, and, although he lived for 8 or 9 days, he was irrational and semi-maniacal. He eventually developed chest signs and died. Both these patients died as a result of poor anaesthesia, and to-day I think neither would have died. The third death was even more unavoidable. A man of 60, who had had pain for years, had a gastrectomy done with pentothal-cyclopropane-curare anaesthesia. The operation was uneventful and he awoke from his anaes-

thetic well, but soon became irrational and shortly afterwards developed an acute mania. Despite all sedation this continued for many days until he eventually died. I think the private mortality rate may be better than the public hospital rate, for the reason that I had more skilled assistance with these patients, though again the hospital patients were a sicker group. When, however, one comes to consider the mortality rate of gastrectomy for carcinoma there is a vast difference. Here we have a necessarily fatal disease, and one which generally presents very late. I think the hospital mortality of all patients admitted with this disease, whether treated surgically, or not, is about 50 per cent. Under the circumstances the operation mortality rate must be high, and in advanced cases requiring the removal of other organs besides the stomach, the rate is high. Again because so many cases are explored, and found to be inoperable it is very hard to get a series of resected cases. In these five years I have been able to find only 22 resections for carcinoma with 7 deaths—a mortality of 31 per cent. This includes all cases, and the analysis is interesting though statistically valueless. There were 7 cases done across the abdomen which should be called partial gastrectomies, without any deaths. There were 2 abdominal total gastrectomies and both died. There were 3 trans-thoracic total gastrectomies and all lived. There were two trans-thoracic partial gastrectomies, and of these one died of pulmonary embolus on the 10th postoperative day whilst walking to the bathroom, and the other lived. There were 8 cases attacked across the chest in which the total gastrectomy was associated with the removal of other organs, spleen, pancreas and/or colon, and of these, four died—a mortality rate of 50 per cent. I do not think that these figures show any more than what commonsense would suggest. One observation is that a partial gastrectomy, even though it be a wide one, is a comparatively safe operation. Of the five uncomplicated total gastrectomies done across the chest, four lived and one died of pulmonary embolus. I would think that these figures suggest that when the cardiac end of the stomach has

to be attacked it should be done across the diaphragm as the abdominal route is associated with difficulties, usually those of access. The eight cases which required a total gastrectomy plus the removal of other organs showed a mortality rate of 50 per cent., i.e., no worse than the total hospital rate for this disease. The fact that four of the eight lived justifies an attack on all these patients. Some may live a little time, and some a little longer. If they obtain but a few months of comfort the effort is still worth while.

CONCLUSIONS.

1. The operation of gastrectomy is now a safe one, and is therefore a reasonable procedure in the treatment of peptic ulcer, and it is the only known possibly curative treatment for carcinoma of the stomach.

2. All modern aids of resuscitation, antibiotics, correct anaesthesia, etc., are an integral part of a completely planned operation.

3. At least 60 per cent. and better, 75 per cent., of the stomach should be removed when operating for peptic ulcer.

4. An ante-colic, iso-peristaltic, anastomosis which leaves a reasonable loop and has a Hofmeister valve makes the best reconstruction after the removal.

5. Suture of the mucosa does no good, and prolongs the operating time without giving any commensurate benefit. Interrupted sutures which produce serosal adhesion are all that is required for anastomosis.

6. Continuous sutures of stainless steel make a very satisfactory closure of the abdomen or chest.

7. The operations for carcinoma which involve the cardiac end of the stomach are best done through a trans-thoracic approach.

8. The cancer surgeon must be careful, gentle, courageous, bold and an incurable optimist.

9. Operations f o r carcinoma of the stomach which include the removal of adjacent involved viscera have a mortality rate no greater than the hospital mortality of carcinoma of the stomach as a whole and are therefore worth while.

REFERENCES.

ALLISON, P. R. (1946), *Thorax*, vol. I, page 239.

BALFOUR, D. G. (1917), *Surg. Gynec. Obstet.*, vol. 35, page 413.

BILLROTH, T. (1881), *Wien. med. Wschr.*, vol. 31, page 162.

BRUNSCHWIG, A. (1947), "Radical surgery in advanced abdominal cancer." University of Chicago Press.

EISELBERG, A. von (1889), *Wien. med. Wschr.*, vol. 39, page 709.

GRAHAM, R. (1940), *Surgery*, vol. 3, page 247.

—— (1943), *Arch. Surg.*, vol. 46. page 907.

HOFMEISTER, F. (1908), *Beitr. klin. Chir.*, vol. 59, page 551.

KAHLSON, G. (1948), *Brit. Med. J.*, vol. 2, page 1091.

KIRSCHNER, M. (1933), "Operative surgery." Translated by I. S. Ravdin, Philadelphia, Lippincott.

KRONLEIN, R. U. (1888), *KorrespBl. schweiz. Arz.*, vol. 18, page 316.

LAHEY, F. and MARSHALL, S. T. (1943), *Surg. Gynec. Obstet.*, vol. 76, page 641.

LIVINGSTONE, E. M. and PACK, G. T. (1940), "Treatment of cancer and allied diseases." New York. Hoeber.

MACLURE, F. (1940), *Aust. N.Z.J. Surg.*, vol. 10, page 64.

MOYNIHAN, B. (1926), "Abdominal operations." Philadelphia, Saunders.

PHEMISTER, D. B. (1943), *Arch. Surg.*, vol. 46, page 918.

POLYA, E. (1911), *Zbl. Chir.*, vol. 38, page 892.

PRIESTLEY, J. P. and KUMPURIS, F. (1948), *Arch. Surg.*, vol. 56, page 145.

RAVEN, R. W. (1941), *Brit. J. Surg.*, vol. 29, page 39.

REYNOLDS, J. T. and YOUNG, J. P. (1949), "Cancer of oesophagus and gastric cardia." Edited by G. T. Pack, St. Louis. Mosby.

SHAPIRO, A. L. and ROBILLIARD, G. L. (1946), *Arch. Surg.*, vol. 52, page 571.

TANNER, N. C. (1948), *Brit. Med. J.*, vol. 1. page 110.

WANGENSTEEN, O. H. (1945), *Canad. med. Ass. J.*, vol. 53, page 309.

SQUAMOUS EPITHELIUM IN ENCYSTED HYDROCELE OF THE CORD.

A NOTE ON SQUAMOUS EPITHELIUM OF PERITONEAL ORIGIN.

By E. S. J. KING.

Melbourne.

"Since nor the exterior nor the inward man
Resembles that it was."

Hamlet. Act II. Sc. 2. 1. 6.

SOME phenomena are observed infrequently and it is natural that, for this reason, they have, to most of us, a significance different from more common conditions. Thus, if some phenomenon appears to cut across our preconceived ideas as to the nature of a particular tissue, when we see it often we come to accept it and its implications (indeed we are compelled to do so) and our ideas change correspondingly, but, when it is less frequently observed, during the long intervals between observations we are able to forget about what is a disturbing matter and the occasional case can be disposed of as some freak not having a real bearing on general problems. Nevertheless we should realize that this psychological quirk, natural enough though it be, is an impediment to progress.

The question arises especially with the occurrence of "aberrant" tissues in various parts of the body, and here we will discuss squamous epithelium. Actually the matter has been settled for many years by competent observers and is generally accepted for conditions often observed, but recent papers show that some of the older demonstrations which are not often confirmed have been overlooked. So the problem is presented here by a discussion of squamous epithelium, of well differentiated form, derived from the peritoneum or mesothelium.

Squamous epithelium occurs normally on the exterior of the body, at each end of the alimentary canal and in the lower part of the genital tract. As a minor pathological change, that is one that is to be seen relatively frequently, it is found in other parts of the alimentary tract (stomach, pancreas, gall-bladder and rectum), in the respiratory tract, even in the bronchioles, and in the urogenital tract (uterus, prostate, bladder and pelvis of the ureter). In all of these the epithelium develops in the site of an already formed epithelium and on a surface which, from the point of view of the body tissues, can be regarded as an "external" surface. Less frequently squamous epithelium is found elsewhere.

The lining of the serous cavities is quite different from that of external surfaces in that it is composed of a single layer of flattened cells which are easily damaged and which readily desquamate. That this lining (referred to as endothelial or mesothelial) may change its form, become cuboidal or columnar or even stratified is mentioned by many writers and recognised by most, if not all, pathologists; nevertheless, the recognition is often half-hearted since cysts in the region, lined by well defined squamous epithelium are usually referred to as "dermoid" and are considered to be "inclusions" due to "displacements" of tissue or to "cell rests." Merely because a squamous epithelium in the peritoneum (only on account of its rarity) seems egregious and strange it is not essential that its explanation should be fantastic.

Recently three examples of hydrocele of the spermatic cord were encountered which gave some indication of the manner of formation of squamous epithelium in a serous surface. All of these examples occurred in old men, the swellings having been present (that is, known to be present) for a relatively short time. They showed different degrees of development of a squamous epithelium.

The problems in elucidation of such observations are (i) determination of the direction in which a process is proceeding, and (ii) the length of time during which the observed state of the tissues has been present.

It is known that hydroceles are commonly (indeed almost invariably) lined by a single layer of serosal cells. It is reasonably certain, therefore, that these atypical hydroceles (provided that they be such and not some other kind of condition) originally possessed such a lining; that is, that an epithelium of some unusual kind did not arise *de novo* but developed as a change in serosal cells. Furthermore, the mode of formation of serosal cells is well known and there is no indication that these come by a change in a more complex cellular structure (and, moreover, an infrequently observed one). The direction of the cellular change is clear.
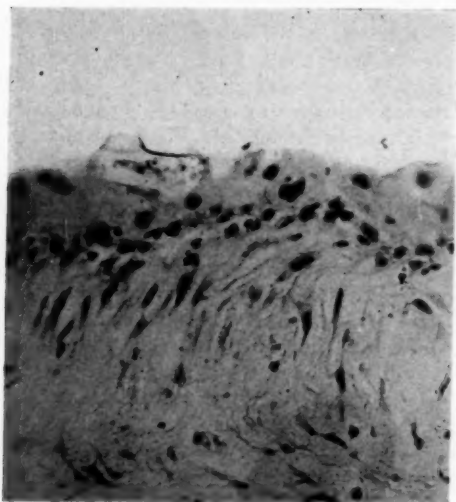

FIG. I. Photomicrograph of a section of the wall of the hydrocele from Case I. There is a thickened peritoneal lining with increase in the number of cells. (x 560)

Secondly, the length of time that a particular tissue has been present is necessarily uncertain, but it is probable that it bears some relation to the length of time that gross morphological changes have been present. When these are observed late in life, any precursor, in the absence of direct evidence to the contrary, is probably one of the commonly observed tissues. Otherwise, evidences of the atypical tissue should be found at an earlier date in some of the many examples examined. Thus, in the cases described here, the epithelium is derived from serosa, rather than, say, epithelium displaced during foetal life.

The cases are described here in order of the complexity of lining of the wall of the hydroceles.

CASE HISTORIES*

Case 1.

The patient, aged 62, had had a swelling in the left inguinal region for five years. It had become larger in the previous twelve months and had presented at the external inguinal ring. The swelling was localized to the inguinal region and upper part of the scrotum, was firm in consistence, fluctuant, translucent to trans-illumination and well defined.

At operation, there was an ovoid swelling lying in the spermatic cord surrounded by vessels and in the lower part by the cremaster muscle. It did not communicate either with the tunica vaginalis or with a small hernial sac found in the inguinal canal. The cyst was removed easily. It measured about 1″ in diameter, had a smooth inner surface and contained a clear serous fluid.

FIG. II. Photomicrograph of a section of the wall of the hydrocele (Case I). There is stratification of the peritoneal cells. (x 440)

Histologically, it was lined by a layer of cells which in some parts were cuboidal to columnar in form with small rounded nuclei. They were well demarcated from the subjacent tissue, but there was

*These cases have been referred to elsewhere though not described in detail. (KING, E. S. J., 1950. The Contribution of Pathology to Biology in *Studies in Pathology, presented to Peter MacCallum*, Melb. Univ. Press.)

no distinct basement membrane (Fig. I). In some parts the cells were double layered; here they were in part cuboidal in form (Fig. II).

Case 2.

The patient, aged 60, had had a swelling in the upper part of the left side of the scrotum for two years. This swelling was separated by an interval from the testis and the head of the epididymis which were readily recognizable.

The cyst was removed by dissection from the strands of the surrounding cremaster muscle and vessels of the pampiniform plexus. The cyst was, after removal, spherical in form and measured 1½ inches in diameter. It contained a straw-coloured serous fluid, and was thin walled and the inner surface was smooth. Histologically, the wall of the cyst was composed of an epithelium which, in many parts, was two to three layers thick (Figs. III and IV). In some parts, however, there were several layers of cells and the superficial ones were flattened and suggested the formation of keratin (Fig. V). This material in most places did not give staining features suggesting keratin.
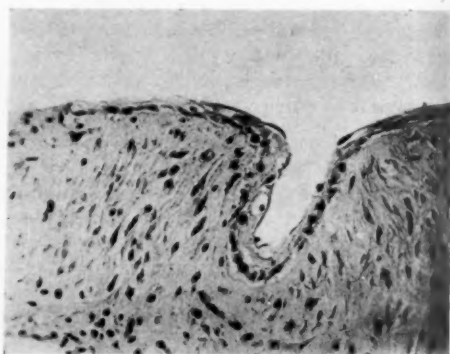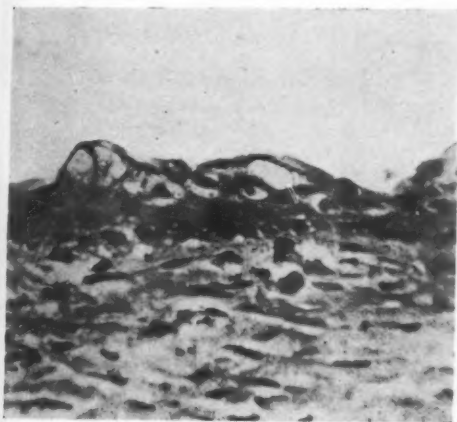

FIG. III. Photomicrograph of a section of the wall of the hydrocele from Case 2. There is stratification of the cells. (x 560)

Case 3.

The patient, aged 67, had had a small swelling in the upper part of the scrotum on the right side for "many" years, but it had become larger during the previous two years. This swelling was about two inches in diameter and was associated with an inguinal hernia (of twelve years duration). On trans-illumination, it was translucent.

At operation for cure of the hernia, the cystic swelling was removed. It lay in the cord amongst the vessels and within the cremaster fascia, and it communicated neither with the hernial sac nor the

tunica vaginalis. After removal it was thin-walled, roughly spherical (but easily deformed) and about 1½ inches in diameter. Its inner surface was smooth and the content was a clear fluid.

FIG. IV. Photomicrograph of a section from Case 2 showing stratification of cells. Some inter-cellular prickles are present. (x 560)

Histologically, the wall was composed of loose fibrous connective tissue and the lining was a stratified epithelium. In some areas the epithelium was composed of several layers of cells, the deep layer being smooth without undulations, cuboidal to columnar in form and in parts without any suggestion of a basement membrane. The superficial cells were not flattened but still flattened in form (Fig. VII). In many areas there were no prickles. In other parts there was a flattening of the superficial cells with keratinization (Fig. VIII). In some areas there was a development of rete pegs and papillae and in these areas there were many prickle cells and eleidin granules. The resemblance to epidermis was remarkable (Fig. IX).

DISCUSSION.

The problem in cases such as these is whether the stratified epithelium arose from peritoneal cells or whether they were derived from some included tissue, for example epidermis. Any conclusion reached has an important bearing on our views regarding their cause; if the epithelium be of simple peritoneal origin, then the condition arose as some pathological change, a metaplasia possibly associated with cell injury and concomitant inflammation in an otherwise normal tissue, whereas, alternatively, it

would be due to some phenomenon of less certain character occurring in early, possibly ante-natal, life.

FIG. V.   Photomicrograph from Case 2 showing stratification of cells. Inter-cellular bridges are present and the cells are flattened. (x 560)

This may not be of practical significance at the moment, but taking the long view and looking forward to when these conditions are more fully understood and prevention, rather than late excision, is paramount, then the time at which it occurs becomes important.

Observation of many examples, in various stages, has led to a general agreement that a stratified epithelium may arise from the peritoneal cells, but as soon as there is evidence of keratin formation, this point of view is abandoned and an extraneous origin for the epithelium is sought. This is why the matter is discussed again here.

The problem is somewhat simpler than that of the development of an epithelium in a connective tissue (King, 1950), since, in a serosa, there is already a differentiation of cells in the direction of formation of a definite lining layer. This peritoneal lining is variously designated endothelium or mesothelium. By some writers, it has been called an epithelium. What term is used is largely a matter of viewpoint.

FIG. VI.   Photomicrograph of a section of the wall of the hydrocele from Case 3. There is definite stratification with flattening of superficial cells and formation of material like keratin. (x 320)

An epithelium is a layer of cells which has a minimal intercellular substance and which lines a surface. It has become customary to limit the term to the tissue lining an "external" surface — skin, the surface of the alimentary canal, the urogenital system, etcetera. It has been applied to derivatives of these, such as liver and pancreas. Attempts have been made to limit the term to tissues which are derived from ectoderm or endoderm; this is either stated or implied in statements in the recent literature. However, this viewpoint cannot be maintained in view of the origin of the urogenital lining from mesoderm. The difficulty is apparent and often remarked on in the case of the adrenal gland where there is an apparent conflict between the histological appearance and the origin of the organ from mesoderm. Such conflict is quite artificial because, as stated, the uterus, ureter and kidney—the linings of which are epithelium — come from mesoderm. Thus it is clear that any attempt to limit the term on an embryological basis is doomed to failure and only causes unnecessary confusion. One must accept the appearance and function of tissues at the time of examination. On the basis of the original

definition, there is no reason why the peritoneal lining should not be regarded as epithelium.
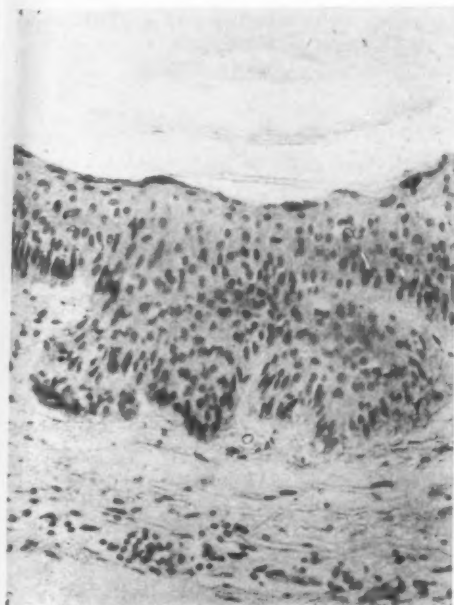

FIG. VII. Photomicrograph of a section of wall of hydrocele from Case 3. There is stratification of cells, this part being thicker than others. (x 320)

The term endothelium is applied to a layer of cells lining an "internal" surface, that is, one which does not communicate with the exterior. This term is used commonly for the layer of cells lining blood or lymph vessels. The lining of the serous cavities is morphologically different from this and phylogenetically it is different in that in some of the lower animals it may communicate, by way of the glomeruli, with the exterior. The difference is emphasized by employment of the term mesothelium. However, whatever name be employed, the lining cells form a pavement epithelium.

In order to determine the origin of the cells lining the hydroceles in the second and third cases described above, it is necessary to see what relation, if any, may be demonstrable between them and those in the commonly found and simple peritoneal lining.

This cannot be determined from examination of one specimen; spatial relationships of cells and tissues do not indicate the direction of either functional or proliferative activity. Nevertheless, a number of specimens may give a clue to the direction of such activity.
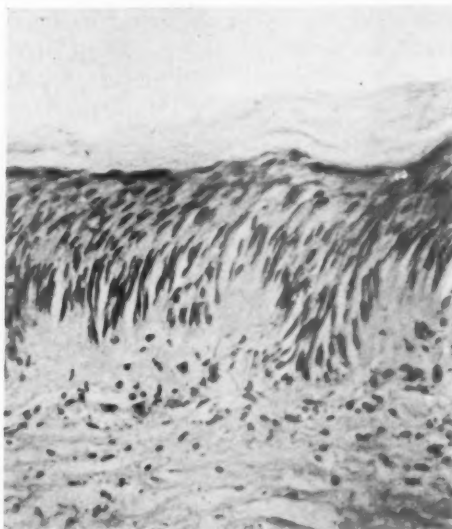

FIG. VIII. Photomicrograph of a section from Case 3. Stratification of cells which are spindle in form. (x 320)

Herniae and hydroceles of the cord occur sufficiently often to allow frequent observations of their walls. The lining is, almost invariably, a single layer of flattened cells such as are seen in the normal peritoneum. Such a lining is to be seen in specimens obtained from patients at all ages. It may be concluded, therefore, that, for the cases where the lining is of this type, however atypical, the epithelium began in this form. In the first case described here there is no doubt that the lining is composed merely of peritoneal cells which have become swollen and more prominent than usual with more than one layer.

In the second case, the cells are also of the same kind. There are intercellular bridges, such as are often seen between peritoneal cells, and even where the cells are multi-layered, their general form is sufficiently

like that of peritoneal cells, either fusiform or cuboidal, for their nature to be clear. Furthermore, gradations in complexity of the lining are found in the one cyst. It is apparent, therefore, that the cells are of peritoneal type, but are arranged in a more complex manner than usual. When ,considered in conjunction with the numerous cysts which have a simple lining, it is apparent that the change occurs in the direction of proliferation and stratification of the single layer of peritoneal cells.
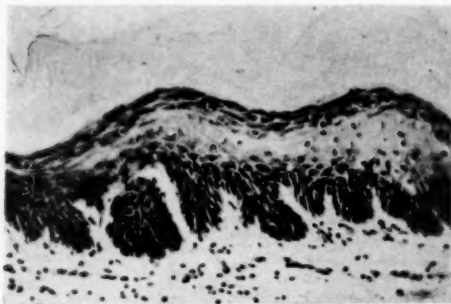

FIG. IX. Photomicrograph of a section from Case 3. The stratified epithelium shows flattening of superficial cells, presence of eleidin granules and keratinous material. There is a close resemblance to epidermis. (x 260)

In the third case, there is a lining which is different from the foregoing in that it is not only stratified but also squamous in type with a layer of keratin on its surface. It is necessary to appreciate first that the general morphology of this cyst is the same as that of the others; it was found in the spermatic cord covered by layers of the cremaster muscle and spermatic fascia; its general form and the character of the lining were similar to those of the others. If we are to postulate some "inclusion" of epidermis, a series of special hypotheses are necessary to explain its peculiar position and relations. One cannot doubt that William of Occam would have accepted its essential similarity to the other examples.

When we examine the wall histologically, the lining, like that of the preceding example, differs considerably in different parts. In some areas it is a simple stratified epithelium not differing greatly from the more complex parts of the specimen from Case 2. The

thickness of the layer varies and in some parts is many cells thick. It is also irregular in some parts with development of projections resembling rete pegs and papillae. These are irregular in other areas where they resemble the downgrowths of "irritated" epithelium. Eleidin granules are present in the cells in some parts and keratin is present (Figs. VI and IX).

Thus there are in these cases all gradations between the simple single-layered peritoneal cells and a squamous stratified epithelium. That they are connected is shown partly by the gross morphology of the cysts in which they are found and the histological gradations between the linings. The direction of activity, that is, the development of a complex epithelium from the simple lining rather than an atrophy of a complex lining (formed for example ante-natally), is indicated by the known simple nature of so many cysts found at all ages. The occurrence of a complex lining in cysts found in the seventh decade is significant in supporting the idea of its being due to a secondary change.

The development of a squamous epithelium in various internal epithelia is well known. It has been described in the peritoneum (Crome, 1950), on the ovary and even in the amnion (Novak, 1940). Its development has nothing to do with the germ layers from which tissues developed nor necessarily with whether the tissue (or some near relative) lines an "external" surface.

The importance of this conclusion is that the observation of a "dermoid" cyst does not necessarily mean more than that there has been a development of squamous epithelium. It does not, of itself, indicate the period of life during which it arose nor does it presuppose some displacement of tissue. The differentiation to actual skin with hairs does impress us but the presence of these appendages should not lead us to the same errors as it did our forerunners. What is necessary is a careful study of these cases to determine the direction and time of tissue developments. The post-natal and aberrant formations of sebaceous glands will be dealt with at another time; here the formation of stratified squamous epithelium in peritoneum only is discussed.

Conclusions.

1. Three cases of hydrocele of the cord with a stratified epithelial lining are described.

2. Gradations between a single layer of epithelium, through a stratified form, to a squamous stratified type with keratin are demonstrated.

3. It is considered that the relation of these various types is such that a development of the squamous epithelium from the peritoneal cells is one of metaplasia of tissues in adult life.

References.

Crome, L. (1950), *J. Path. Bact.*, vol. 62, page 61.

King, E. S. J. (1950), *Aust. N.Z.J. Surg.*, vol. 19, page 208.

Novak, E. (1941). "Gynecological and Obstetrical Pathology," Philadelphia. W. B. Saunders Company, pp. 272, 467.

OBSERVATIONS ON THE SURGICAL ANATOMY OF THE THORACO-LUMBAR SYMPATHETIC SYSTEM.

By K. C. BRADLEY.

Melbourne.

MANY recent discussions devoted to the surgery of the sympathetic nervous system have been connected with the residual pathways to certain areas after conventional sympathectomy. Ray and Console (1948) claim, for example, that after bilateral excision of the sympathetic trunks from the inferior cervical to the fifth lumbar ganglion, residual pathways were present from the twelfth to the third lumbar dermatomes.

It is the purpose of this paper to describe some of the anatomical variations seen in the lower thoracic and lumbar portions of the sympathetic chain which are considered of importance in the surgery of this region. Failure to appreciate these variations would account for some of the failures to denervate the area intended.

MATERIAL

The dissections were performed on twenty dissecting room subjects with the aid of a binocular loupe. From these dissections dioptographic tracings were made. Attention was directed in particular to the lower thoracic and lumbar chains, their ganglia and rami and to the relationship of the sympathetic chain and the splanchnic nerves to the diaphragm.

THE SYMPATHETIC CHAIN AND SPLANCHNIC NERVES.

The thoracic sympathetic chain is situated along a line immediately anterior to the costo-vertebral joints as far caudally as the tenth thoracic level. From this level it passes anteriorly along an oblique line so that at the level of the second lumbar vertebra it is located in the groove between the antero-lateral aspect of the vertebral bodies and the medial border of the psoas major muscle. The chain usually enters the abdomen under the medial edge of the medial arcuate ligament (medial lumbo-costal arch), a short distance below and

lateral to the point of entry of the lesser and least splanchnic nerves. In most cases it will be found by following the lateral border of the crus of the diaphragm upwards.

At the level of the first lumbar vertebra the greater splanchnic nerve is placed medial to the sympathetic chain with the other splanchnic nerves between these two structures.

The greater splanchnic nerve pierces the muscular portion of the crus of the diaphragm at the level of the first lumbar vertebra and then turns medially at almost a right angle to enter the coeliac ganglion; dividing frequently into two branches as it pierces the crus.

The remaining splanchnic nerves enter the abdomen in a variable manner below and lateral to the point where the greater splanchnic nerve pierces the crus. They may pierce the crus or enter the abdomen between the slips of attachment of the crus to the vertebrae.

A nerve passing beneath the medial arcuate ligament with the sympathetic chain is more likely to be a contribution to the splanchnic system from the first lumbar ganglion.

An uncommon, but nevertheless important variation is shown in Fig. V in which the sympathetic chain and some splanchnic nerves pass under the median arcuate ligament with the aorta.

It is also noteworthy that satellite filaments of the main splanchnic nerves may leave the parent trunks above the diaphragm and enter the abdomen independently. Thus, in addition to variations in the manner in which the splanchnics enter the abdomen, there are variations in disposition of these satellite filaments, some of which may be so fine that they would escape detection if the approach were solely sub-diaphragmatic. Unless the splanchnic nerves are identified

above the diaphragm and gentle traction applied to them or to the sympathetic chain, fine filaments, entering the abdomen via the aortic opening, through the crus or under its slips of attachment to the vertebra, are easily overlooked.

These variations illustrate the difficulty of dividing all sympathetic filaments entering the abdomen from the thorax when a sub-diaphragmatic approach is made.

THE GANGLIA.

There are a great number of variations in the number, sites and types of ganglia, particularly from the eleventh thoracic level caudally. All the anatomical variations may be explained if reference is made to their development as described by Pick and Sheehan (1946).

At an early stage in development there is a ganglionic mass corresponding to each spinal nerve. This mass splits into a cranial and a caudal portion, each remaining connected by rami to the corresponding nerve. These primordial ganglionic masses may fuse in a number of ways producing several types and combinations of adult ganglia.

A general description will be given of some of the arrangements of lower thoracic and lumbar ganglia followed by reference to particular cases taken from the dissecting room. These cases will be illustrated by comparing them with the primordial ganglionic masses (Figs. IA, IB, IIA, IIB).

It is important to remember that sympathetic neurones, not present as macroscopic ganglia, may be found outside the sympathetic chain, for example on the rami.

Thoracic Ganglia.

The thoracic ganglia from the third to the tenth generally follow a segmental pattern; that is, their rami are distributed to the corresponding intercostal nerve.

The ganglia are situated at the level of the inter-vertebral disc between the corresponding vertebra and the next lower in the series. For example, the tenth thoracic ganglion is placed at the level of the disc between the tenth and eleventh thoracic vertebrae.

The rami, which are short and usually two to three in number, pass obliquely upwards either medially or laterally to the intercostal nerve. The white rami join the intercostal nerves distal to the grey rami.

The last thoracic ganglion.

The commonest arrangement is that of a large ganglion placed either at the level of the intervertebral disc between the eleventh and twelfth thoracic vertebrae or on the body of the twelfth thoracic vertebra and referred to as "the last thoracic ganglion." There may be fusion with ganglia above or below or additional small satellite ganglia may be present. These extra ganglia may represent the separated half of a primordial ganglionic mass.

The rami from the last thoracic ganglion are distributed to the eleventh intercostal and subcostal nerves. The directions of the rami are obliquely upwards to the eleventh intercostal nerve and downwards to the subcostal nerve, or, if the ganglion is more caudally placed, upwards to the eleventh intercostal nerve and almost transversely to the subcostal nerve (Figs. IA and IIA).

Lumbar Ganglia.

The lumbar sympathetic chain, particularly in its more cranial portion, shows many variations in the number, size, type and location of ganglia. Not only is this true from individual to individual but on the two sides of the one individual. This should be emphasised because division of the lumbar sympathetic chain at a particular level wih respect to the vertebrae will not necessarily denervate the same area of the lower limb in two cases, nor even on the two sides of the same individual. The reasons are clear if the arrangement of the ganglia and their rami are compared in Figs. IA and IIA. Fig. IA shows a lumbar ganglion situated at the level of the disc between the third and fourth lumbar vertebrae which is connected by rami only to the fourth lumbar nerve, whereas in Fig. IIA a ganglion situated at approximately the same level is connected by rami to the third and fourth lumbar nerves. Thus excision of this ganglion will produce a different result in the two cases.
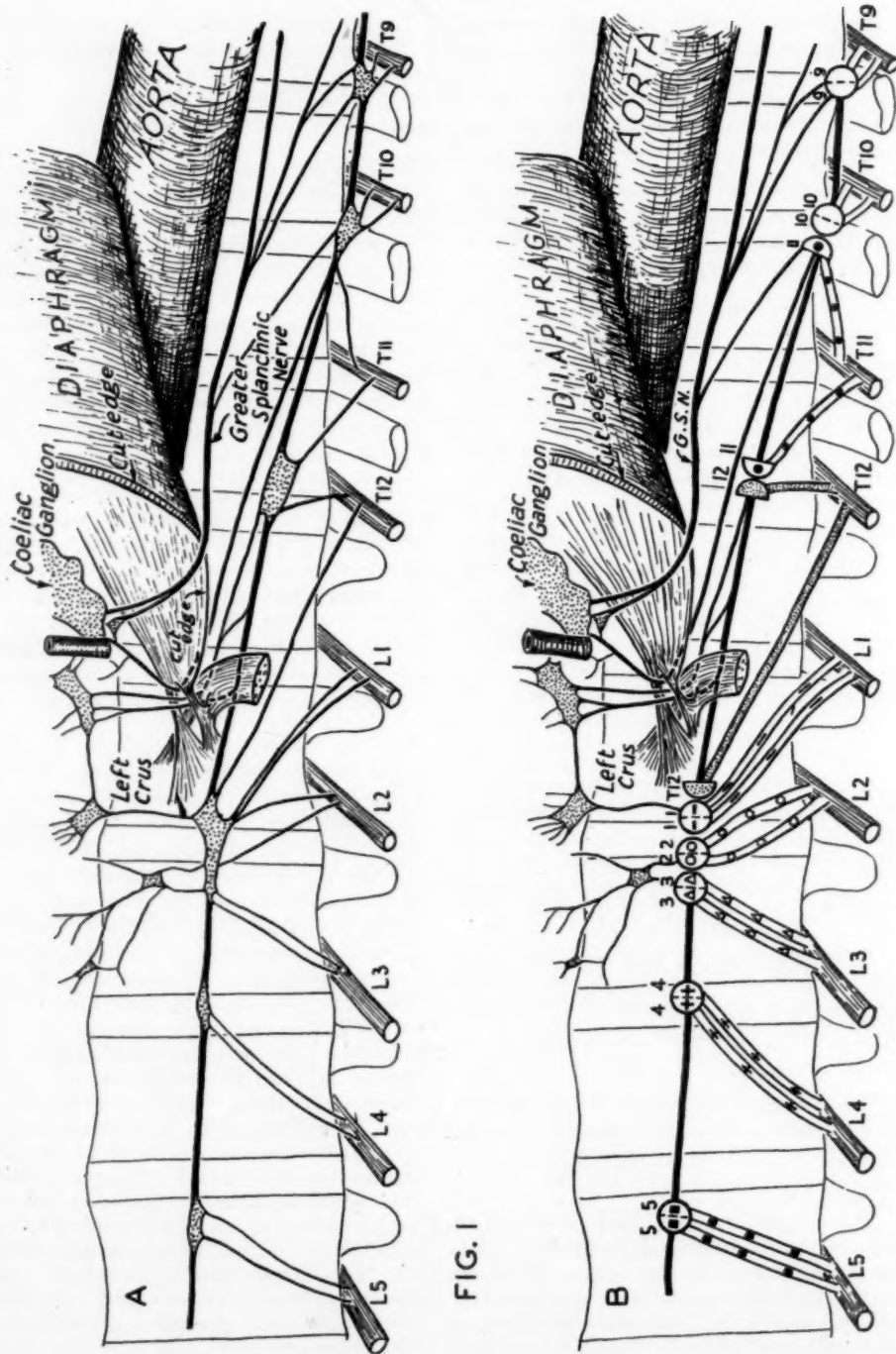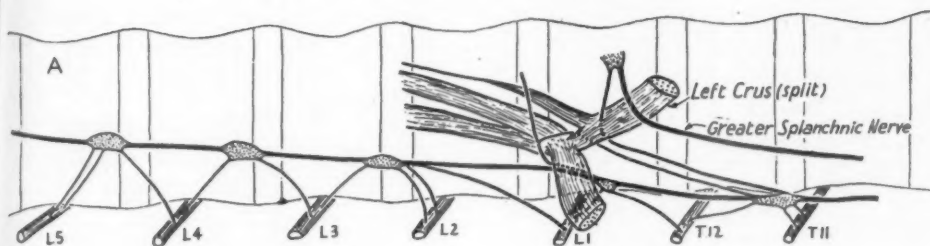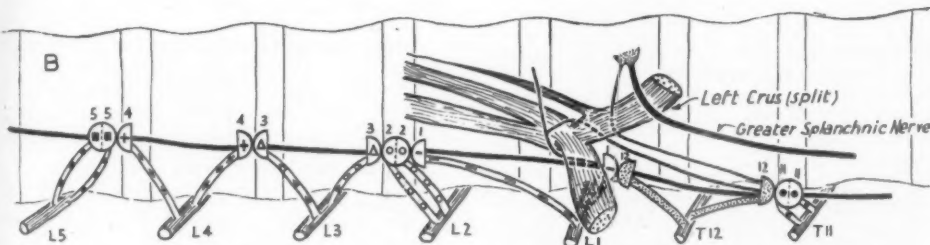
FIG. 1

FIGS. IIA and IIB. The thoraco-lumbar sympathetic chain, rami communicantes and splanchnic nerves have been displayed together with the left crus of the diaphragm. The ganglia have been analysed as in Fig. IB.

The lumbar ganglia may be represented as any number from one fused elongated mass up to six separate ganglia. A ganglion located on a certain lumbar vertebra does not necessarily have the same developmental origin in two cases. There is only one way to label a ganglion and that is according to its connections with the anterior primary rami via the rami communicantes.

In the upper part of the lumbar series it is usual for ganglia to be connected to more than one nerve whilst at the caudal end of the lumbar chain they are commonly connected to only one nerve.

The first lumbar ganglion when present is situated on the body of the lumbar vertebra or on the disc between the first and second lumbar vertebrae and its rami connect it with the subcostal nerve and the first lumbar nerve. However, it may be absent in this situation because it has become incorporated in the ganglia above or below.

The second lumbar ganglion is usually the largest and is situated on the body of the second lumbar vertebra or on the disc below. If it is formed from the fusion of the whole or portions of the first and second lumbar primordial ganglionic masses it will be connected to the first and second lumbar nerves. Figs. IIA and IIB, however, show an example derived from the fusion of the whole of the one and portions of two other primordial ganglionic masses, in this case therefore its rami connect it with three spinal nerves.

In Figs. IA and IB a ganglion situated at approximately the same level is derived from the fusion of three and portion of one other primordial ganglionic mass, and is therefore connected via its rami communicantes to four spinal nerves.

It is obvious, therefore, that a ganglion can be designated only by its rami communicantes and if the developmental origin is kept in mind one can account for all the

FIG. IA. The thoraco-lumbar sympathetic chain, rami communicantes and splanchnic nerves have been displayed together with the left crus of the diaphragm.
FIG. IB. The ganglia of the sympathetic chain in Fig. IA have been analysed according to their developmental origin. The numbers opposite the ganglia refer to the body segments.
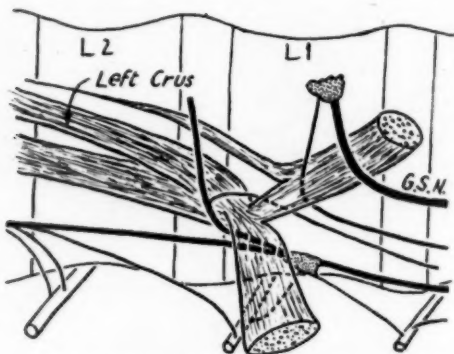(Illustrated on previous page.)

FIG. III. Detail of left crus of diaphragm, sympathetic chain and splanchnic nerves.
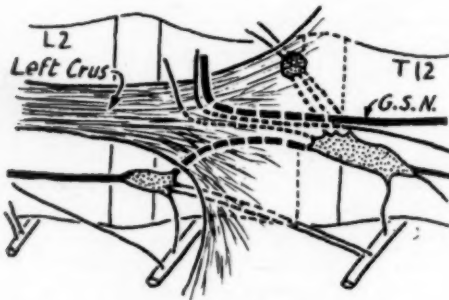

FIG. IV. Detail of left crus of diaphragm, sympathetic chain and splanchnic nerves.
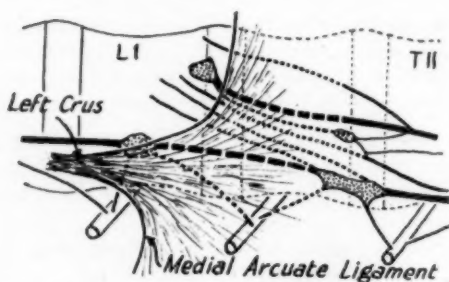

FIG. V. An uncommon variation in which the sympathetic chain and splanchnic nerves enter the abdomen via the aortic opening.

types seen anatomically. The dissections show ganglia with rami communicantes distributed to one, two, three and four spinal nerves (Figs. IA, IB, IIA, and IIB).
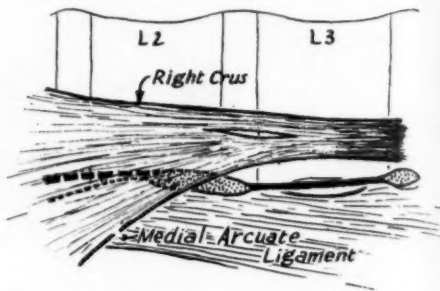

FIG. VI. A ganglion situated on the second lumbar vertebra partly hidden by the medial arcuate ligament.

RAMI COMMUNICANTES.

The foregoing remarks illustrate that by following the distribution of the rami communicantes one can designate a ganglion according to its developmental origin.

The rami communicantes are distributed to one nerve from the third to the tenth thoracic level whilst below this examples are shown where they are distributed from one ganglion to up to four nerves. In the lower lumbar region they commonly tend to be distributed again to only one nerve.

The lengths of the rami communicantes increase from the tenth thoracic level caudally because the chain passes anteriorly relative to the corresponding nerves.

In a typical case the lengths of some of the rami communicantes were as follows:—

Ninth ganglion to ninth intercostal nerve	10 mm.
Tenth ganglion to tenth intercostal nerve	10 mm.
Last thoracic ganglion to eleventh intercostal nerve	11 mm.
Last thoracic ganglion to subcostal nerve	22 mm.
Second lumbar ganglion to first lumbar nerve	48 mm.

It is well to realize the dimensions of rami and that it may be important to remove the maximal length possible when performing sympathectomy because ganglia other than those situated along the sympathetic chain may be present along the rami. It is not

practicable to remove the whole length of a lumbar ramus because of its relationship to the psoas major muscle but by keeping the above fact in mind at least some of these synapses may be removed.

PRACTICAL IMPORTANCE OF VARIATIONS IN LUMBAR GANGLIA.

The distal limit of sympathetic outflow from the spinal cord takes place usually via the anterior primary ramus of the second lumbar nerve so that there are no white rami communicantes below this level.

A reasonably adequate sympathectomy of the lower limb will be achieved if the upper limit of division of the chain is such as to include the so-called second lumbar ganglion. This large ganglion situated on the body of the second lumbar vertebra or on the disc between the second and third lumbar vertebrae is the most constant of all, is usually the largest and can be regarded as the key ganglion with respect to lumbar sympathectomy. In Fig. IA if the proximal division of the chain were performed on the body of the third lumbar vertebra below this ganglion sympathetic fibres would still be distributed peripherally in the first, second and third lumbar nerves.

DIFFICULTY OF ACCESS TO THE THORACO-LUMBAR SYMPATHETIC SYSTEM.

In the region immediately superior to the diaphragm, the sympathetic chain and splanchnic nerves are rather difficult of access, wedged as they are between the superomedial surface of the crus and the vertebral bodies. If particular care is not taken, a ganglion could be left intact and portion of the sympathetic outflow would remain.

The lumbar sympathetic chain is usually easily accessible, but at times it may be deeply situated in the groove between the medial border of the psoas major and the lumbar vertebral bodies. Some ganglia may be partly hidden under the fibrous arches of attachment of the psoas major to the vertebral bodies and discs, and are tethered in this situation by their rami.

Again the ganglion situated on the second lumbar vertebra or on the disc below may be obscured by the medial arcuate ligament or by muscular slips passing from the psoas major to the diaphragm (Fig. VI).

SUMMARY.

1. A description has been given of some anatomical variations in the lower thoracic and lumbar sympathetic chains.

2. The ganglia have been analysed according to their segmental origin.

3. Some of the relationships of the sympathetic chain and splanchnic nerves to the crura of the diaphragm have been described.

4. Mention has been made of some facts of importance in performing sympathectomy.

REFERENCES.

PICK, J., and SHEEHAN, D. (1946). *J. Anat.*, vol. 80, page 12.

RAY, B. S., and CONSOLE, A. D. (1948), *J. Neurosurg.*, vol. 5, page 23.

SEQUELAE OF TREATMENT OF HYDATID CYSTS OF THE LUNG.

By S. C. FITZPATRICK.

Hamilton.

UNDER present day conditions patients who have an unruptured hydatid cyst of the lung completely removed by surgical methods with adequate safeguards will usually have a smooth convalescence. Serious sequelae should be uncommon and the mortality rate under 1 per cent.

Where patients are first seen with the cyst already ruptured, complications will be more frequent and the mortality will approximate 5 per cent.

The main sequelae are:—

1. Anaphylactic shock.

2. Lung hydatid abscess, persistent cavity, and chronic empyema.

3. Recurrence of daughter cysts.

4. Fibrosis and bronchiectasis.

This paper is based on my personal experience of 80 cases of lung hydatid including 7 cases treated by my partner, Mr. John Kneebone. Of these 80 cases, 70 have been followed up. Twenty were classed as unsatisfactory during part or all of their post-operative course. The remaining 50 watched over periods from twenty-eight years to one year, show no sign of any persisting post-operative pulmonary lesion attributable to a lung hydatid.

Fatal Cases.

There were four deaths following operation (5 per cent. mortality).

1. E.J.W., female, aged 55, died of acute anaphylactic shock during operation on 2nd Jan., 1943. This is the only fatal case in this series since 1935 and will be detailed later.

2. M.F., female, aged 38, had had frequent haemoptysis for six months and her general condition was not good. She was operated upon for a hydatid cyst of the right middle lobe on 18th July, 1924. Acute pyo-pneumothorax ensued on the fourth day and death on the eleventh day. Probably inefficient control of negative pressure drainage was the main factor responsible here, but nowadays preparation with adequate blood transfusion and control of infection with antibiotics would have greatly widened the safety limit.

3. J.W., male, aged 58, had drained pus from a chest wound for two years following an operation elsewhere for a ruptured cyst of the right lung. He was admitted gravely ill with a rightsided pneumonia and a foul empyema. Under local anaesthesia on 14th Sept., 1922, free drainage was provided. He died on the third post-operative day. Neglect on the patient's part to obtain earlier treatment of the persisting empyema appears to have been the main reason for this death.

4. A.H., female, aged 72, weight 6 stone; was first seen with emaciation and a broncho-biliary fistula from a liver hydatid cyst. At operation on 15th Oct., 1935, drainage of the cyst was carried out. Death followed three weeks later from inanition.

GROUP 1.

ANAPHYLACTIC SHOCK.

We have had three cases which we consider died because of this complication but as two of them occurred without having been operated upon they are not detailed here.
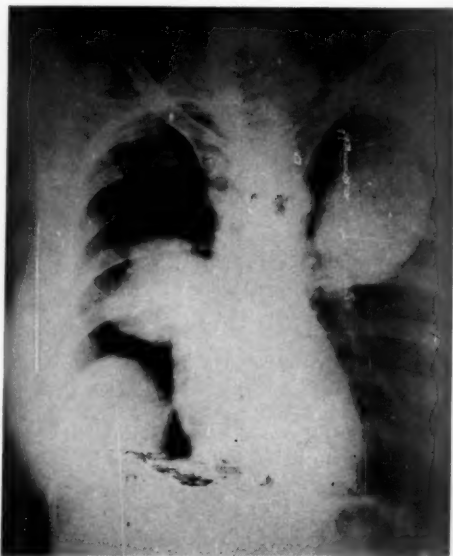

FIG. I. E.J.W. Multiple bilateral cysts; fatal anaphylactic shock.

The third patient was a female, E.J.W., aged 55, with one cyst in the right lower lobe, and one in each of the right and left upper lobes (Fig. 1). All cysts were approximately four inches in diameter. The cyst in the right lower lobe ruptured before admission to hospital and was evacuated at operation on 19th Sept., 1942. Whilst awaiting further operation, the cyst in the right upper lobe ruptured and the patient became gravely ill due to anaphylactic shock. This cyst was evacuated at operation on 18th Dec., 1942. It was realized that the patient was now highly sensitized to hydatid fluid; and that if the remaining cyst in left upper lobe ruptured, the patient had little chance of survival. On 2nd Jan., 1943 under endotracheal anaesthesia, the cyst in the left upper lobe was exposed, but before it could be opened, a fluid rattle was clearly heard in her chest; her face immediately became pallid, her heart ceased beating shortly afterwards and all measures at resuscitation including cardiac massage, were fruitless. No pathological condition adequate to cause death was revealed at autopsy. It was considered that death was due to a slight leakage of hydatid fluid into a pulmonary blood vessel causing acute anaphylactic shock.

Reviewing the management of this case we consider her only chance of survival was to have had both cysts of the right lung removed at the first operation, and the third cyst removed within the next fourteen days. Her general condition during the first operation, however, was such that it was considered unwise to undertake the removal of the cyst in the right upper lobe at that time.

Lendon (1902) pointed out that these patients die from shock and not from asphyxia.

Animal experiments (Best and Taylor, 1945) have shown that fatal anaphylactic shock is accompanied in the dog by strong constriction of the caval ostia of the hepatic veins, cessation of the outflow of blood from the liver, great swelling of the liver and death from shock. In the guinea-pig anaphylactic shock is accompanied by strong contraction of the muscles of the bronchioles with death from asphyxia; while in the rabbit there is strong constriction of the pulmonary arteries with death due to failure of the right ventricle.

The peculiarities of the anaphylactic manifestations in different species can be accounted for largely by the amount of smooth muscle in the reactive tissues. The point worth emphasis here is that when a lethal dose of hydatid fluid is introduced intravascularly, the human reacts in a manner similar to that of the dog.

Multiple attacks on multiple cysts in the lung and elsewhere are recognized as being accompanied by a greater risk.

Many are now convinced that general anaesthesia confers no protection against fatal anaphylactic shock.

Since anti-histamine substances have become available, we use them as a routine pre-operative measure, but further investigation is necessary to ascertain whether they afford adequate protection

GROUP 2.

LUNG HYDATID ABSCESS, PERSISTENT SAC, AND CHRONIC EMPYEMA.

Incomplete removal of the parasitic cyst wall, whether spontaneously or by surgery, results in most cases in an infected cavity lined by a comparatively smooth fibrous wall, containing a foreign body and communicating with the bronchus or with the pleural cavity or with both.

Some patients are first seen at this stage. This "lung hydatid abscess" has become better understood from the study of the chronic putrid lung abscess, but the two are not strictly comparable. The chronic putrid lung abscess passes through a shaggy-walled granulomatous stage and only after a long period of time may acquire a smooth epithelial lining. The lung hydatid abscess with its smooth fibrous lining may be looked upon as comparable with the late epithelialized stage of the chronic putrid lung abscess. The presence of a thin adventitia in hydatid abscess is a great advantage while it is resistant to the spread of infection, but is a disadvantage when the adventitia has become one-quarter to one half an inch thick, and when irreversible changes have occurred in the surrounding lobe. Emptying the cavity in this late stage will almost certainly be followed by a persistent sac, in many respects comparable to a thick-walled non-collapsible cavity in a tuberculous lung, and in like manner, requiring lobectomy. The fibrotic changes in the adventitia and the "obstructive pneumonitis" type of change in the surrounding lung which follow chronic infection in a ruptured and incompletely emptied hydatid of the lung, explain why there is a time limit to the possibility of cure

with complete recovery of lung function. Where total expulsion of the fluid (containing hydatid "elements") and cyst wall occurs within this time limit, whether spontaneously or by surgery, complete recovery can follow.

negative Casoni and hydatid complement fixation tests. Expectant treatment was decided upon. Six years later he returned with haemoptysis. Radiography showed an hydatid cyst at the apex of the left lung. At operation an old cyst containing daughter cysts was evacuated. He has remained well for the past ten years.
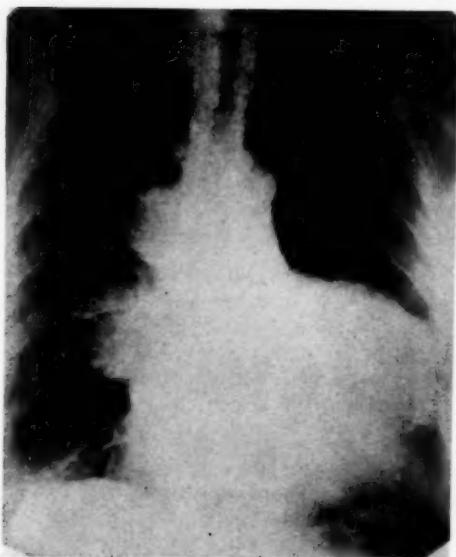

FIG. II. D.McL. Multiple bilateral cysts ; before rupture.

FIG. III. D.McL. Two months after rupture of cysts.

Mrs. McL., now aged 70, (see Figs II, III, IV) on being X-rayed showed 5 cysts closely grouped around the bronchi in July, 1922. Two weeks later she was admitted to hospital with bronchopneumonia and severe coughing, during which she coughed up all of the cysts. Since then I have watched her for twenty-eight years and no clinical or radiological evidence of any serious sequel has appeared.

Following either spontaneous intrapleural rupture or the operative removal of the contents of a lung hydatid abscess, tension pneumothorax or acute pyo-pneumothorax leading to chronic empyema, are the most serious sequelae. This clinical picture occurring spontaneously in this country should make one careful to eliminate the possibility of an underlying hydatid. In this series three patients were first seen with hydatid pneumothorax and four were first seen with chronic empyema. Two of the former are of interest.

A.B., male, aged 19, was first seen with spontaneous pneumothorax on left side. Investigation gave no evidence of tuberculous infection and
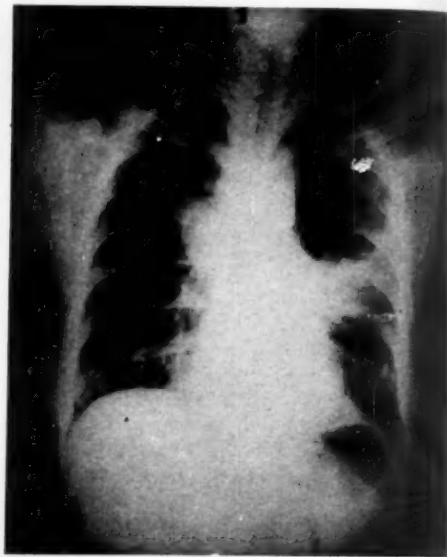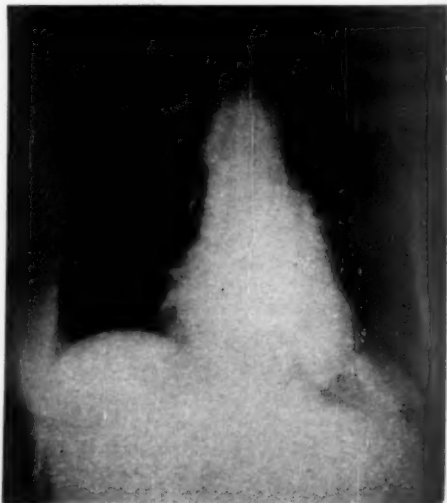

FIG. IV. D.McL. One year after rupture of cysts ; complete cure by natural expulsion.

A.V., female, aged 35, was first seen in a critically ill state with intrapleural rupture of a hydatid cyst of the lower lobe of the right lung, causing a pyo-pneumothorax (Fig. V), and with an unruptured cyst in the upper lobe of the left lung. Thoracotomy was carried out, the right pleural cavity and the cyst cavity cleaned out and negative pressure drainage established. One week later, the cyst in the left upper lobe was removed. She was discharged from hospital after four weeks.

FIG. V. A.V. Multiple bilateral cysts; rupture of cyst in right lung; pyo-pneumothorax.

It is considered that adequate negative pressure drainage combined with chemotherapy in this patient were important factors in preventing chronic empyema and in aiding the closure of the broncho-pleural communication.

The adventitia in persistent cavities may become completely lined with an epithelium-like covering and the cavity then resembles an infected congenital cyst. This has been illustrated previously by Brown (1942).

Chronic empyema following ruptured hydatid (Fig. VI). If the hydatid elements have been completely removed and no persistent adventitia lined cavity remains, the treatment of empyema in such a patient differs in no way from empyema due to other non-tuberculous causes. A number of cases have been recorded in which both hydatid and tuberculous disease were present in the lungs at the same time.
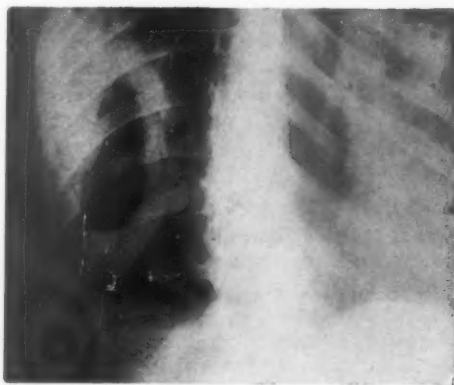
FIG. VI. J.H. Thick-walled cavity in right lung 20 years after rupture of cyst; a small bronchial communication is present.

We consider that adequate safeguards against this group of sequelae include:—

(a) Avoidance of soiling of the pleura by the use of a combined suction bell and trocar-cannula. This catches the first inevitable leakage from the highly tense cyst and can be used to remove by suction most of the fluid and if necessary the whole parasitic wall. (Fitzpatrick, 1945.)

(b) Negative pressure drainage of the residual cavity and of the pleural cavity until the bronchial communication which in large cysts commonly results at operation, is proved to have closed and until the cavity has disappeared. This should be proved by X-ray after injection of contrast fluid.

(c) Frequent X-ray studies including bronchography if closure is unduly prolonged.

GROUP 3.

"RECURRENCE" OF DAUGHTER CYSTS.

The growth of daughter cysts is due to the incomplete removal of the cyst fluid containing brood capsules and scolices and may occur in the cyst cavity, the pleural cavity, or the tissues of the chest wall. We find that unless special safeguards have been taken, growth of daughter cysts is more common where removal of an unruptured cyst has been followed by aseptic healing

than where infection of the residual cavity has occurred. Dew (1927) has shown that daughter cysts can survive in purulent fluid by virtue of the resistant power of the laminated membrane. It appears, however, that the brood capsules and scolices are killed by infection of the cavity.

We feel that refinements in technique should obviate this sequel. Where we suspect that hydatid elements may still be present, and where no bronchial communication exists, in addition to the safeguards used for the preceding group, we rub the interior wall of the completely emptied cavity with a swab moistened with 7 per cent. solution of formalin. "Formolage" of a lung cyst by injection prior to emptying would run the risk of formalinized fluid getting into the bronchial tree and is certainly unsafe.

In a most interesting analysis of 478 cases by Waddle (1950), he expresses his scepticism of the value of formalin. We suggest that the term antiseptic is not pertinent where formalin is being used as a direct lethal chemical agent to kill scolices and brood capsules in an empty advential sac not in communication with a bronchiole.

Barrett (1949) at operation uses a method of extrusion of peripheral cysts in an unruptured state which entirely eliminates the risk of pleural sowing. *Inter alia* he (1947) includes the recurrence of daughter cysts as an indication for lobectomy. We are not aware of the evidence upon which he bases his advice and without this we cannot agree that lobectomy is necessary.

GROUP 4.

BRONCHIECTASIS.

Before giving my own experience of this sequel, it will be of value to refer to a most instructive paper dealing with this subject. Blanco and Capurro (1934), of Monte Video, during 1930 to 1931, performed 115 bronchographs on 84 patients suffering from ruptured hydatid cysts. Professor Dévé, of Rouen, during a stay in Monte Video in September, 1932, personally analyzed their results and said, "This chapter is absolutely new and merits the attention of physicians and surgeons. They should study with

lipiodol the bronchial tree of every patient who has had hydatid vomiting if the evolution is in the slightest way retarded. I thought that the existence of local bronchiectasis in the region of the old cyst was relatively a very rare complication in the surgical series. . . . You have taught me the contrary . . ."

The pertinent conclusions of Blanco and Capurro's paper are:—

1. The closed (un-ruptured) hydatid cysts modify only slightly the permeability of the bronchi and the motility of the broncho-alveolar system; only when they are very large can they produce para-hydatid atelectasis.

2. To cure a hydatid cyst of the lung completely, spontaneous expulsion or surgical evacuation must occur in a rapid and complete form.

3. If evacuation is incomplete, the retention of parasitic remnants, with peri-cystic inflammation, is made manifest clinically by purulent sputum and haemoptysis, continuous or intermittent, and radiologically, by pulmonary sclerosis, cavity formation and bronchiectasis.

4. Many patients with such a clinical picture and radiological findings present themselves primarily at this stage with a badly defined origin; the incomplete prior hydatid expulsion has passed unperceived.

5. The unknown number of such unrecognised cases makes it impossible to judge exactly the prognosis of hydatid cyst of the lung and the result of therapeutic procedures applied.

6. Two types emerge from radiological studies, a cavity-forming suppurative type and a bronchiectasis-producing type. Blanco and Capurro and others contend that even where the best conditions have been present for obtaining a complete clinical cure of a closed (pre-operatively unruptured) hydatid cyst and where years of freedom from clinical signs of disfunction in the lung have ensued, yet bronchography will show persisting changes in the bronchi. For example, narrowings or dilatations, irregularities, with loss of bronchial motility and lack of alveolar expansion may be shown present.

Review of our series shows that only those patients with persistent symptoms are likely to return for review and submit to bronchography. For this reason we are not in a position to refute or support the opinions held by Blanco and Capurro.

There are, however, several observations worth recording. Hydatid cysts are found more often in the lower than in the upper lobes of the lungs. This statement is equally true of bronchiectasis in general. Bronchiectasis occurring years after the removal of hydatid cysts from a lung may not be a consequence of the cyst damage but might have developed had the patient not had hydatid cysts.

An example of this was Miss McC., aged 64. In 1933 I investigated her for chronic cough and purulent sputum. She proved to have a bronchiectasis in the right lower lobe. Twenty-eight years previously, Sir George Syme, through a thoracotomy, had trans-pleurally drained a hydatid cyst in the upper part of the right lobe of the liver. The wound remained closed after three months. Though this was a liver cyst, I consider it as pertinent to this subject; it was the first case of bronchiectasis I had encountered following treatment of an hydatid cyst. This patient, of course, could have developed bronchiectasis from other causes than the liver cyst or the operation for it.

Dew (1927) records a case of bronchiectasis in right lower lobe which followed treatment of a Rendu's type No. 2 communicating hepato-bronchial cyst.

Blanco and Capurro do not indicate what percentage of their simple cysts were followed by bronchiectasis. It is our opinion that extremely few simple cysts operated upon with adequate safeguards will terminate with bronchiectasis of clinical significance. We agree that once a chronic suppurative process has developed following the rupture of a hydatid cyst in a lobe, bronchiectasis may be expected as a possible result.

Hydatid disease of the lung masquerades under many different disguises such as acute pneumonia, pleurisy, spontaneous pneumothorax, tuberculosis with haemoptysis and cavity formation, empyema, bronchiectasis, lung abscess and tumour. This study of late sequelae emphasized the fact that patients may present in the late suppurative stage of their disease when the hydatid origin has been unrecognised and is extremely difficult to establish.

It has been stated that the large hydatid cyst which occupies most of a lobe commonly produces para-cystic collapse, and that therefore the lobe should be excised. We have not found this to be so. Providing there has been no process of infection causing permanent changes in the lung parenchyma, the compressed lobe at operation expands at once. For this reason we cannot subscribe to Barrett's suggestion that largeness of a cyst alone is an indication for lobectomy.

A discussion of morbidity rates in treatment of lung hydatid cysts must include the effect of the advances in anaesthesia, in blood transfusion, fluid and electrolyte balance; in chemotherapy, and in antibiotics, and in the special ablative procedures of lobectomy and pneumonectomy, as well as advances in the better understanding of the control of lung physiology after operations. This series extends over twenty-eight years and the only fatal case in the past fifteen years was that due to acute anaphylactic shock. Until about fifteen years ago, lobectomy could not reasonably be recommended as the treatment of choice for old lung abscesses, persistent thick-walled cavities, and the like. It had to be shown that the mortality rate of lobectomy in the hands of surgeons called upon to treat hydatid disease was at least equal to the mortality rate of the conservative method; at the same time it had to be shown that lobectomy gave results superior to the drainage method.

The position of lobectomy may now be regarded as well established as the treatment of choice for old lung hydatid abscesses, persistent thick-walled cavities, and where the diagnosis remains in doubt after the thorax is opened.

Lobectomy would provide an adequate method of dealing with severe bleeding from the walls of a cavity during operative removal of a cyst. Lobectomy might also be necessary as the final stage operation in an hepato-bronchial fistula.

SUMMARY.

The results of treatment of 80 cases of hydatid cyst of the lung are given: 4 were fatal; the sequelae discussed are:— Anaphylactic shock; Lung hydatid abscess; persistent cavity, and chronic empyema; recurrence of daughter cysts; fibrosis and bronchiectasis. Methods of prevention and treatment of sequelae are referred to.

REFERENCES.

BARRETT, N. R. (1947), *Thorax*, vol. 2, page 21.
—— (1949), *Lancet*, vol. 2, page 234.

BEST, C. H. and TAYLOR, N. B. (1945), "Physiological basis of medical practice." 4th edition. Baltimore. Williams and Wilkins. Page 263.

BLANCO, R. P. and CAPURRO, F. G. (1934), *Arch. Internat. Hydatidosis*, vol. 1, page 227.

BROWN, C. J. O. (1942), *Roy. Melb. Hosp. Clin. Rep.*, vol. 13, page 66.

DEW, H. R. (1927), "Hydatid disease," Sydney. Australian Medical Publishing Co., pages 82 and 217.

FITZPATRICK, S. C. (1945), *Aust. N.Z.J. Surg.*, vol. 14, page 270.

LENDON, A. A. (1902), "Hydatid disease of the lung." London.

WADDLE, N. (1950), *Aust. N.Z.J. Surg.*, vol. 19, page 281.

TECHNICAL ASPECTS OF THE SURGERY OF HYPERTENSION WITH A FOLLOW-UP OF FIFTY CASES.

By Douglas Miller.

Sydney.

THE first promising attempts to apply surgical methods to the correction of hypertension were made by Peet and Adson. In their approaches to the sympathetic chain and splanchnic nerves, both used limited access, the one above the diaphragm through a small para-vertebral resection of the eleventh rib, and the other beneath the diaphragm through a subcostal approach. The good reports coming from these two distinguished pioneers arrested the attention of the world. Smithwick later opened the field by evolving a wide combined thoraco-lumbar approach which has gained wide advocacy, firstly because of the claim that a more radical resection of sympathetic nerves gives better objective results, succeeding sometimes where a conservative approach has failed, and secondly that it escapes from the more difficult technical problems attendant upon the other operations.

The disadvantages of the Smithwick approach are the size of the incision, the necessity for rib resection and intercostal nerve retraction or section, which result so often in most troublesome neuralgia, and the time consumed by the whole procedure.

Admitting that a wider resection is likely to give better results, the surgical problem becomes one primarily of access. Some British surgeons advocate an open thoracotomy with incision of the pleura over the chain, and division of the diaphragm from above, the chain being followed down into the lumbar region. A limited experience of this did not encourage me to believe that it was easier, though it does avoid rib resection and nerve section.

Stock (1948) has referred to the adaptation of Fey's renal approach for this work. I have now been using this for some time and have no doubt as to its superiority over other methods. It is quickly done, avoids rib and nerve section and gives most excellent access above and below the diaphragm. It is followed as a rule by a minimum of discomfort.

THE INCISION.

The incision is carried along the line of the eleventh rib from the outer edge of sacrospinalis forward into the lateral abdominal field. The soft tissues are separated subperiostially along the whole length of the upper surface only of the eleventh rib and the flank muscles arising anteriorly are separated. The rib is then depressed and the diaphragm, pleural reflection and subphrenic fat lie displayed.

It is my practise to open the subphrenic space first and explore the kidney and suprarenal, though I have yet to find a suprarenal tumour. The greater splanchnic nerve is quickly isolated, clipped and divided, the lumbar chain followed down and divided at the desired level and then followed upwards and isolated from the rami as far beneath the arcuate ligament as possible—only the anterior part of the diaphragm is divided. The retro-pleural dissection is then performed, the pleura usually pushing away very readily from the chest wall; the chain and splanchnic nerves are then followed up as high as possible, usually to about the level of the seventh thoracic vertebra, and divided. The splanchnics and chain may then be pulled up through the diaphragm and removed as a total specimen.

Needless to say this operation calls for the help of a most expert anaesthetist, as the subjects are often poor risks and show alarming fluctuations of blood pressure. In addition it is not uncommon to open the

pleura. The anaesthetist must use a controlled respiration technique and can give great aid by the use of relaxant drugs.
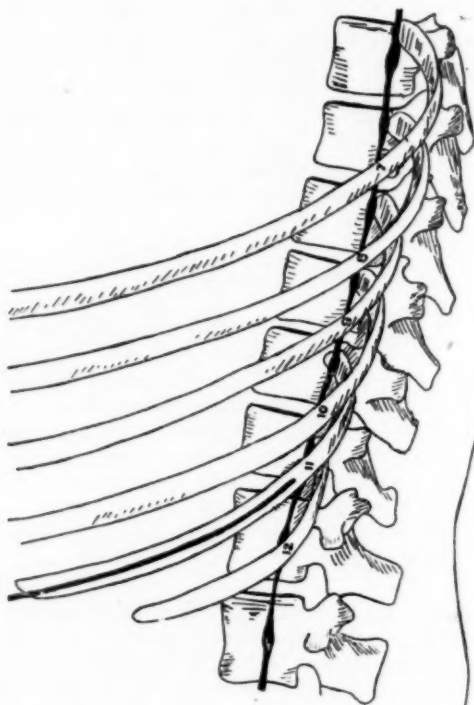

FIG.I. The incision is centred over the 11th rib and extends from the outer border of the sacrospinalis muscle forward into the abdominal muscles.

This operation usually takes half to three-quarters of an hour.

This is an excellent routine approach, though there is no doubt that the more limited operations still have a place in bad risk patients, in whom I have sometimes carried through as many as four separate sessions. Patients with angina should first have a high dorsal resection performed.

COMPLICATIONS.

In vaso-motor collapse, the lethal period is associated with immediate post-operative movement. I have seen two unexplained sudden deaths in this period and now insist on full recovery taking place before the patient is transferred to the ward. Vaso-pressor drugs will tide over crises in this period.

Pneumothorax and effusions are apt to occur but only once have they given rise to alarming symptoms.

Occasionally where a great fall in blood pressure has occurred a quite alarming cerebral anaemia becomes evident with mental confusion and urinary incontinence as the striking features. This usually improves within a few days, but in one of my patients the sustained cerebral anoxia led to permanent intellectual damage.

The subcostal neuralgia so common with the Smithwick operation, is not noted with the Fey approach, though transient and apparently severe backache may occur.

RESULTS.

The results of this branch of surgery may be assessed either on a basis of relief from disabling symptoms or as an objective lowering of blood pressure. These two effects do not necessarily go hand in hand and the reason for performing the operation should be taken as the basis for assessing the results. There are then two groups: The first are those with severe symptoms such as disabling headache, fatigue, giddiness and emotional instability, who seek relief from their disability. If they achieve sustained relief without any considerable drop in pressure I think the operation must be considered worthwhile, and judged a success.

The other group are those who have few, if any, symptoms and seek operation as an aid to increasing their expectation of life. For this group there is no easy criterion of success, except a sustained fall in blood pressure and the probably justifiable assumption that this will increase their expectation of life.

In the first group, relief of symptoms in most of my patients means little less than revolutionising their existence and outlook

on life. Intense disabling headaches will cease and fatigue be forgotten, and this often without much drop in pressure.
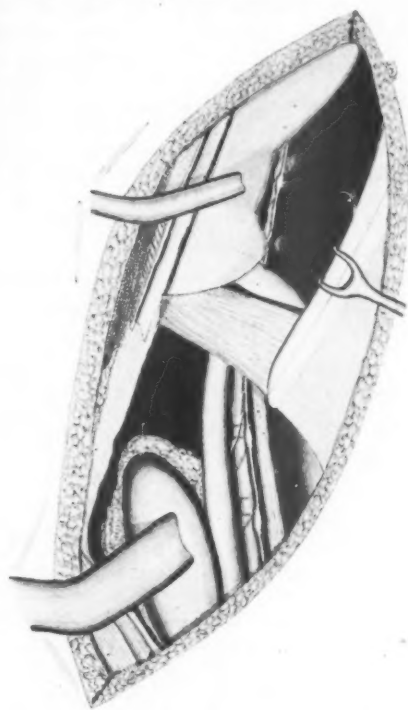

FIG. 11. The 11th rib has been depressed and the intercostal space widely retracted. The diagram indicates the wide exposure obtained both above and below the diaphragm and the ready access to the kidney. The diaphragm has not required division.

Even with moderate drop in pressure, eye grounds grossly swollen or pathological may revert to more normal appearance, and hearts becoming decompensated will recover subjectively and objectively.

My follow-up has been made on 50 private patients who have been taken without any selection, the longest have been operated on five years and the shortest one year.

Thirty-nine of this 50 fall into Group 1, (operated on for relief of symptoms).

30 females; 9 males.

24	Complete relief.
9	Partial relief.
5	No relief.
1	Hypotensive.

There have been two immediate post-operative deaths, and two who have died within the follow-up period.

Study of the present blood pressure readings shows:

9	Normal.
21	Substantial drop.
9	Unchanged.

Substantial drop means a fall of not less than 50 mm. systolic and 20 mm. diastolic.

The relief from symptoms cannot be readily fitted into any objective class.

Of those with unchanged pressure, 3 had no relief; 3 partial and 3 complete.

Of those with normal pressure 7 had complete relief; one partial and one severe hypotensive symptoms.

Of those with a substantial fall:

14	Complete relief.
2	No relief.
5	Partial relief.

Turning over the pages of these cases reveals many most interesting records.

One woman three years ago, had a severe malignant hypertension with intense headache and papilloedema. She has been grouped under those with complete relief and a substantial fall in blood pressure. Another woman operated on a year ago with a malignant hypertension of 300/140 mm. to-day has a normal blood pressure but is incapacitated by hypotensive symptoms.

A nurse with severe hypertension and who was completely incapacitated had no objective fall but gained such relief that she went back to enjoy normal life for a year when she died of apoplexy.

An ageing school teacher had a slight stroke and was severely incapacitated by symptoms; she gained a considerable drop in blood pressure and has been enjoying normal life for two years.

Analysis of the second group, i.e., those operated on in an endeavour to drop the blood pressure:

There were 11 in this group, 8 males and 3 females. Of these, 6 were unaltered and 4 died within a year — all were males approaching fifty years of age. There was one operation death in the same group. One young male and one female have normal

blood pressures. Two have maintained a substantial drop, and one is unaltered and alive with a high blood pressure at the end of four years.

This small series would appear to indicate that men approaching fifty years of age who are operated on because of a rising hypertension do not yield worth-while results, whereas young adults appear to be more hopeful.

A follow-up was made of 20 ex-servicemen operated on in the Repatriation Hospital. This is a more difficult group to analyse, because it would be impolitic for them to protest any alleviation of symptoms. In this group, therefore, we have on paper no grateful patients. Only 5 achieved a good objective fall in blood pressure. The majority were men in the 5th decade and the few good objective results were recorded in younger men.

Taking then an overall view of this branch of surgery we can survey the field of action with a feeling of satisfaction which is at least comparable to that achieved in most other branches of major surgery, but if I were to summarise in a few words, I would say that it is better to look on it not as an operation to cure blood pressure, but to bring relief from its effects.

Smithwick, Palmer and others have had the opportunity of following large series of cases from five to ten years. It is only from such large numbers followed through for longer periods that any assessment of the life-prolonging value of the operation can be obtained. To date there seems to be no doubt that in groups 1, 2, 3 (Palmer *et al*, 1946) a very considerable increase in life expectation can be promised, whereas people falling into group 4, do not yield worth-while results.

SUMMARY.

A description of Fey's renal incision modified for thoraco-lumbar sympathectomy is given.

A follow-up of 50 patients up to five years, is reported.

The results are classified as symptomatic and objective.

REFERENCES.

PALMER, R. S., *et. al.* (1946), *New England J. Med.*, vol. 130, page 467.

PEET, M. (1935), *Univ. Hosp. Bull, Ann. Arbor.*, vol. 1, page 17.

SMITHWICK, R. H. (1940), *Surgery*, vol. 7, page 1.

—— (1948), *Brit. Med. J.*, vol. 2, page 237.

—— (1949), *Surg. Clin. N. Amer.*, page 1699.

STOCK, F. E. (1948), *Ann. Roy. Coll. Surg., England*, vol. 3, page 306.

DIAPHRAGMATIC DEFORMATION OF THE LIVER.

By G. S. CHRISTIE.

Melbourne.

ALTHOUGH it is probable that the liver, in common with other major organs, possesses an intrinsic geometrical shape, it is more readily moulded by its surroundings than most. This results in such a wide variability of its proportions that Cruveilhier was constrained to remark that he, with Vesalius, was tempted to deny the liver a determinate form.

This paper deals with one of the commonest of these deformations, the presence of single or multiple regular grooves penetrating the upper surface.

The anomaly has been mentioned by anatomists since the beginning of the modern era, and during the last hundred years, several authors have discussed the conditions of its occurrence. Very few papers have appeared in the English language. Lane (1888) and Symington (1898) merely mention the anomaly. Moody (1905), in a valuable paper reviewed the literature and described cases he had observed. Short accounts, chiefly of the radiological aspects were published by Singer and Boikan (1933) and Ballon (1935).

Since most of the case groups hitherto reported have been small there is still some uncertainty about such factual data as the age and sex incidence and the frequency of associated conditions which might be etiologically important. The present enquiry, on a group of nine hundred consecutive autopsies, was initially undertaken on these questions. Later it became apparent that important observations have been inadequately stressed or omitted from the literature altogether.

It is therefore worthwhile to describe in detail the chief anomalies of the upper surface of the liver, and the associated diaphragmatic changes. This constitutes the first part of the paper.
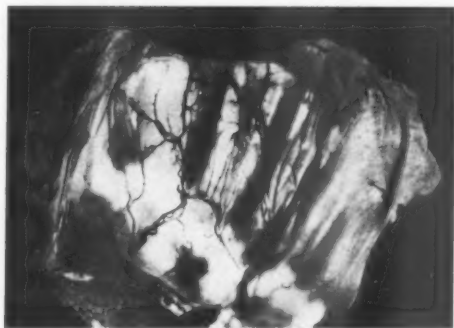

FIG. I. Photograph of part of the right dome of the diaphragm corresponding to liver illustrated in Fig. II. The photograph was obtained by a brief exposure to intense transmitted light followed by a longer exposure to direct light. The dark zone at the lower left is the muscle of the lumbar part, and was attached to the bare area of the liver. The central tendon transmits light freely. The sterno-costal part is subdivided by light and dark bands, due to thick and thin areas of the muscular sheet. The thick bands correspond in number, size and position to the grooves in the liver.
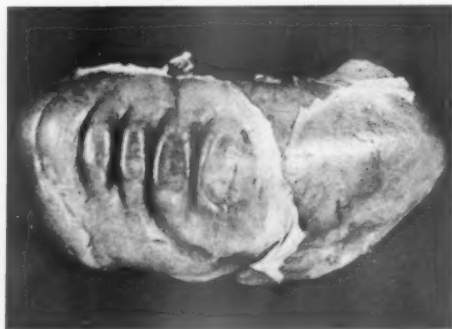
FIG. II. Photograph of liver showing four deep grooves in the anterior surface of the right lobe and a fifth shallow groove more laterally placed. The slight flattening of the intervening ridges and capsular wrinkling over the left lobe are fixation artefacts; at post-mortem the capsule was smooth and transparent. The peritoneal reflection at the bare area of the liver is visible; anterior to this the superior surface is ungrooved where it underlies the central tendon. The corresponding diaphragm is illustrated in Fig. I. The subject was a thin male, aged 80.

PART 1.

DIAPHRAGMATIC GROOVES OF LIVER.

General Features. The grooves under discussion occur on either lobe of the liver, but are much more frequent on the right side than the left. The ratio has been estimated as 9:1.

They usually appear first on the sharply curved border separating the upper surface from the front and right lateral surfaces of the organ. They are found to be deeper and longer—as well as more numerous—in older age groups, suggesting that the process once begun is progressive. From their starting point the grooves extend downwards, on the front and lateral surfaces, further than they do in an upward direction on the superior surface.

In the past, when the liver was descriptively considered to be a flat disc with anterior and posterior surfaces only, the grooves were often stated to be vertical, and to pass into the liver substance in a sagittal direction.

from the body, the grooves are approximately radial, spreading out fanwise from the zone covered by the central tendon of the diaphragm, and lying in the direction of the muscle fibres of the sterno-costal sheet. When small they usually pass into the liver substance at right angles to the plane of the surface, but deep grooves may become oblique (Fig. VII). Those situated far to the lateral side may have a backward inclination even when small.

The grooves are usually approximately parallel when viewed from the front or from the right side, but may converge sharply, either above or below. From the same aspect they may appear as straight lines (Fig. II), or as sweeping arcs. When curved, the convexities of adjacent grooves may point in opposite directions like a pair of brackets (Fig. VIII).

The grooves, even when very deep, have not been observed to reach the inferior border of the liver. At their upper ends they
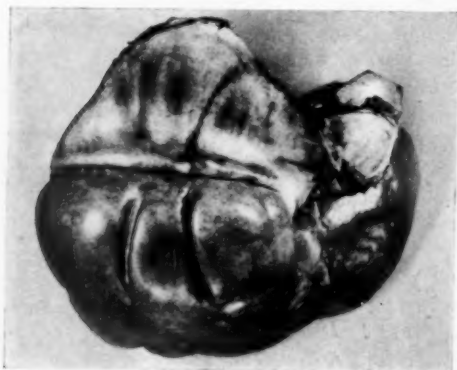

FIG. III. Photograph of liver of male subject, 61 years old, moderately obese. The part of the right dome of the diaphragm attached to the specimen shows a fold corresponding to each of the two deep grooves. The diaphragm was not trans-illuminated, the texture therefore is not indicative of irregularities of thickness.

This description is not appropriate to the organ in its natural position in the body, and probably arose from examination of fresh specimens which flatten out when placed on a table (Friedel, 1922). If the liver is observed from above before removal

FIG. IV. Photograph of inferior surface of part of the sterno-costal muscle sheet of right dome of diaphragm. The corresponding liver is shown in Fig. V. The three ridges of muscle A, B, C, occupied grooves in the liver.

rarely extend into that part of the upper surface under the central tendon of the diaphragm, and never as far as the peritoneal reflection of the anterior layer of the coronary ligament between the liver and the diaphragm. The most laterally placed grooves, however, may cross the posterior border very obliquely, extending into the bare area of the right lobe behind the apex of the right triangular ligament.

The foregoing may be summarised by the statement that they may occur in any part of the liver covered by the muscular fibres of the sterno-costal sheet of the diaphragm, irrespective of whether or not peritoneal surfaces intervene.

The commonest number of grooves is three; the antero-medial members are more frequent than the postero-lateral ones and are usually deeper, longer and further apart although there is great variation in this respect. The middle or even the posterior members of a series may be the best developed. The largest number observed in the right lobe in this series was seven. The average number increases with age.
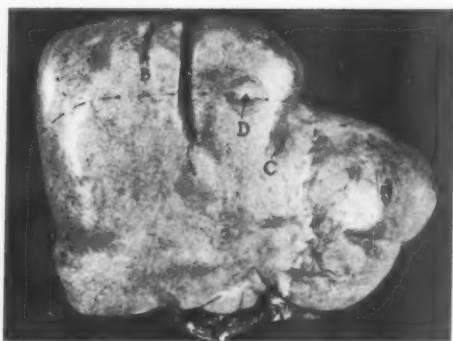

FIG. V. Photograph of liver (weight 2,400 g.) from a female aged 76. Moderate biliary cirrhosis is present. The lungs were normal. A large hump projects upwards from the antero-superior surface of the right lobe. The hump is crossed by a deep groove (A) and by a second shallow groove (B). Note the secondary hemispherical elevation (D) forming on the front surface of the hump. The medial edge of the hump (C) is an inch away from the falciform ligament. The dotted line indicates the approximate position of the upper border of the liver prior to the development of the hump. The hump is due to a general bulging of the costal muscular sheet of the diaphragm.

The faintest grooves are usually wide, smooth and shallow, but even at this stage they may be quite narrow and sharp. As they grow deeper the sides become steep, but on cross-section the floor of the groove usually retains a smooth curve rather than a sharp angle (Fig. III).

Relation to Hepatic Disease.

In agreement with most previous observers, no constant abnormality of the peritoneum, liver capsule or parenchyma under the grooves or over the intervening ridges could be found. Slight microscopic changes may be present, but these are insufficient to account for groove formation. Inflammatory or neoplastic disease of the liver (Figs. VIII, IX), are infrequent aetiological factors in adults. In the majority of such cases the disease process probably conforms to a pre-existing groove pattern, although it is quite possible that prolonged external pressure may modify the shape of even a cirrhotic liver.

Terminology.

Simple terms descriptive of position such as "vertical," "sagittal," "anterior," "parallel," have fallen into disuse because of their inevitable inaccuracy when applied to such complex three dimensional structures.

The term "space grooves" (Westenhöfer. 1921) depends on an aetiological hypothesis which has not been accepted by later observers. The eponymous "Liebermeister grooves" (Adami, 1911) is unjustified.

Most authors have concluded that the grooves are caused by the diaphragm. The term "diaphragmatic grooves of the liver" has gradually gained currency, and in spite of its length has many advantages. The intervening elevations will be referred to as "diaphragmatic ridges of the liver."

The diaphragmatic changes which cause these distortions of the upper surface of the liver are described and discussed below.

DIAPHRAGMATIC "BOSSES" OF THE LIVER.

The diaphragmatic "boss" is illustrated in Fig. VIII. It consists of an elevation on the antero-superior surface of the right lobe,

usually clearly demarcated on the medial and lateral sides, but merging gradually into the superior and anterior surfaces above and below.

FIG. VI. Photograph of liver from thin male aged 83. Two grooves are present. They do not extend upwards into the area under the central tendon. Weight, 1,200 g. Normal microscopic structure. Lungs normal. Death from cardiac infarction.

DIAPHRAGMATIC "HUMP" OF THE LIVER.

The diaphragmatic liver "hump" is an elongated razor-back occupying almost the whole lateral extent of the antero-superior border. The long axis is approximately coronal. It is illustrated in Fig. V, where all the liver tissue above the dotted line is a protrusion beneath a thin and yielding costal shee. of the diaphragm except for the two sharp grooves which are also present.

In common with the more frequent grooves, bosses and humps are confined to the part of the liver underlying the muscular part of the diaphragm which arises from the ribs and costal cartilages. They differ in being commoner in females than in males.

All three types of deformity are due to alterations in the diaphragm of the same fundamental character. A large hemispherical boss, and even a hump of the whole anterolateral border, is merely an exaggeration of the ridge formation seen in the typical grooved state (Fig. II). Combined forms occur quite frequently.

NON-DIAPHRAGMATIC DEFORMITIES OF THE LIVER.

There are certain other deformities of the liver which merit attention to distinguish them from diaphragmatic grooves.
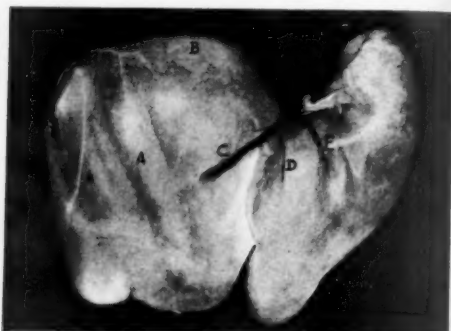

FIG. VII. Photograph of liver from thin female aged 66. The thorax was small, the ribs oblique, and the diaphragm elevated on each side. C, D, E, F, are grooves of the common type and probably antedated the group of changes indicated by the extreme obliquity of the costal impressions (A). The groove (C) indicates the direction in which the overlying diaphragmatic muscle fibres were working, and is grossly malaligned relative to the ribs. A hump (B) has formed beneath a weaker zone of the costal muscle sheet.

(1) Costal Impressions.

(a) Bony Shafts of Ribs. These impressions are found on the front and right lateral surfaces of the liver, and on the posterior border. The faintest may be of post-mortem origin, but the deeper ones are ante-mortem and there may be thickening of the peritoneum and liver capsule over the impressions. They are flat and shallow, and correspond in direction to the ribs, which are usually almost vertical. The diaphragm lying between the rib shafts and the liver is thin and the dome high. True diaphragmatic grooves may be present on the same liver, but they always lie at a more cranial level (Fig. VII).

Sometimes the direction of diaphragmatic grooves corresponds to that of the ribs, and this probably accounts for Liebermeister's view that the sagittal grooves were of costal origin (Friedel). However, diaphragmatic grooves are readily distinguishable from rib imprints by the morphology of the grooves and the diaphragm.
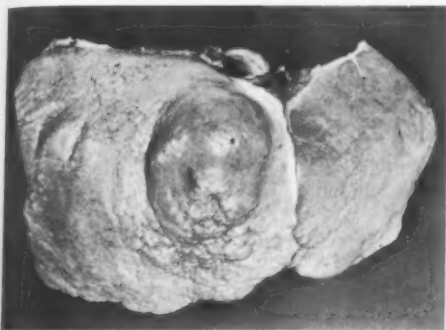
FIG. VIII. Photograph of liver from male 88 years of age. Weight, 1,330 g. Two shallow grooves are present laterally, and a medially placed "boss" is demarcated by two curved grooves. All grooves corresponded to muscular bands in the diaphragm. The overlying sheet of muscle was very thin. The cirrhosis was probably nutritional in origin and developed after the grooving began.

(b) Costal Cartilages. The cartilage of any of the lower six ribs may indent the liver. The cartilage complex formed anteriorly by the 7th, 8th and 9th ribs particularly, may form a transverse depression across the front surface of the liver. The peritoneum may become thickened and the part of the lobe below the costal margin may become snared off from the main mass of the right lobe to a varying degree, forming a Riedel's lobe. In this series the association of such a transverse groove with diaphragmatic grooves was not greater than was expected from the incidence of the two conditions.

(2) Clefts Due to Peritoneal Folds.

A small triangular wing-like fold of peritoneum may be pulled down from the reflection from the diaphragmatic muscle on to the bare area of the liver behind the right triangular ligament (Fig. XI, E). This occurs only if a thickened band of muscle is also present in the diaphragm at this site. The peritoneal band produces a sharp-edged cleft in the liver superimposed on the upper part of the groove formed by the muscle band. Such clefts have been observed only after fixation of the liver *in situ* by perfusion. They may therefore be artefacts, although their depth makes this unlikely.

In any case, they are much rarer than and strictly secondary to the formation of diaphragmatic muscular bands, and of liver grooves of the ordinary type.

(3) Clefts Due to Local Scarring.

There is no difficulty in differentiating these from the foregoing types since a scar of sufficient size to produce clefts does not disappear completely. In this series, such clefts radiating from shrunken retrogressed hydatids were occasionally encountered. At the bottom of the triradiate cleft illustrated in Fig. X, there was an area of fibrosis containing cystic spaces lined by bile-duct epithelium. Local polycystic areas were found elsewhere in this liver, but none of the others showed fibrosis.
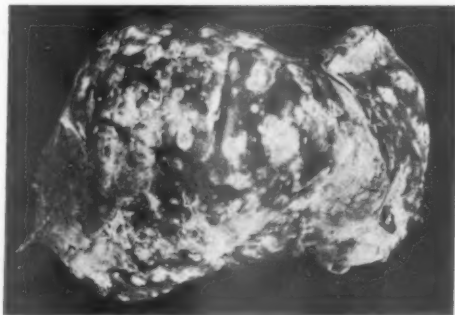
FIG. IX Photograph of liver, weighing 6,820 g. from a male subject 77 years of age with carcinoma of prostate. The groove probably antedated liver enlargement and was independent of it.

(4) Grooving of Liver by a Loop of Bowel.

This occurrence is described by Kaufmann (1929). No example was encountered in this series.

(5) Fissures of Inferior Surface.

Sharp edged fissures of the inferior surface of the liver are common. They often show a complete curvature, the peritoneal lining is normal and there is no underlying scarring (Thomson, 1899). They are quite distinct from diaphragmatic grooves and are rare on the upper, lateral, or anterior surfaces.

DIAPHRAGMATIC CHANGES ACCOMPANYING GROOVING OF THE LIVER.

In every case in which liver grooves were found, the sterno-costal muscle sheet of the diaphragm was arranged in thick and thin bands when viewed by transmitted light (Fig. I). The thick bands correspond to the grooves in length, direction and degree of development. When the grooves are wide and shallow the thicker muscle bands are also wide. A band gradually becomes the crest of a crescentic diaphragmatic fold directed towards the abdomen (Fig. IV). The fold lies in the groove and corresponds to it in size. At this stage, the fold may be found at post-mortem to have retracted a little from the groove, but this is probably a result of opening the abdominal cavity after death. There is good radiological evidence that folding exists during life. When the grooves are very gross the bunched up crests of the folds may be retained firmly in grooves which are wider at the bottom than at a more superficial level (Fig. XIV).

FIG. X. Photograph of liver from male aged 65. The sides of the triradiate cleft A have been opened up. There was no anomaly in the overlying diaphragm. A collection of small cysts and a little fibrous tissue were found at the bottom of the cleft. Groups of cysts were scattered through the substance of the liver, one of these presents on the surface at E. B, C and D are grooves of the common type, and were accompanied by diaphragmatic bands.

Folds are not found in the absence of thick and thin band formation in the diaphragm and only the well developed bands form folds. The upper surface of a fold may be bridged by a pleural adhesion, but this is rare, and contraction of an adhesion cannot be held to be a cause of fold formation.

Band formation is usually well advanced before the hepatic deformation begins, and the thick bands cause distinct grooving of the liver prior to the development of folds.

Weltz and Glauner (1933) believed that distortion of the line of attachment of the diaphragm or of the thoracic outlet might throw the diaphragm into the folds which groove the liver.
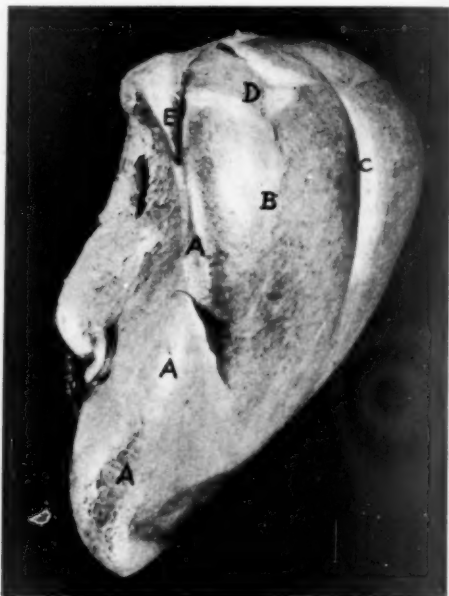
FIG. XI. Right lateral view of liver from a male aged 81. Three grooves, A, B and C, are present. A and B are due to muscular bands both attached to the 12th rib. D is the apex of the right triangular ligament and E is a cleft occupied by a triangular double fold of peritoneum.

Against this conclusion are the following observations:—

1. Band formation precedes fold formation.

2. Neither the thick and thin bands, nor the folds which the thick bands later produce can be traced laterally as far as the thoracic wall. In the vast majority of cases

the outer third of the sterno-costal sheet is of uniform thickness when trans-illuminated, and the folds die out in this zone.

3. Diaphragmatic bands and liver grooving may occur in the absence of distortion of the line of origin, or of the thoracic outlet.

4. Conversely, the line of origin may be grossly irregular or serrated in the absence of thick and thin band formation.

FIG. XII. X-ray of chest of female, 46 years of age. The right diaphragmatic arc shows a double contour.

5. When band formations and distortions of the line of origin co-exist, a consistent co-relation with the nature of the distortion cannot be made out. If the fibres of the band are dissected out to the periphery, they may attach to the crest of a wave or serration, or to the pit between adjacent crests or to an intermediate position. In the case of the 10th, 11th, and 12th ribs, the fibres of a thick muscular band may be traced to any part of the costal or intercostal line of attachment.

The thick bands constitute only a fraction of the fibres of an anatomical slip of origin, and two thick bands may develop in a single slip. They do not correspond consistently to recognized subdivisions of individual diaphragmatic slips.

Band formation is an intrinsic development in the inner two thirds of the sterno-costal muscle sheet of the diaphragm. It does not occur in the sheet arising from the arcuate ligaments possibly because of its relative shortness and thickness, although a general bulging of this sheet is sometimes to be observed.

The bands usually extend medially as far as the central tendon. The tendon shows no alteration of thickness although sometimes a well-developed fold may extend for a short distance into the tendon.

FIG. XIII. X-ray of chest of male of poor physique 25 years of age. Both diaphragmatic shadows have a multiple arc contour. The patient suffers from asthma and allergic rhinitis.

The question of distortion of the line of origin of the sterno-costal sheet of the diaphragm merits further consideration. Normally this line runs laterally with a gentle sweep from the xiphoid process of the sternum, along the conjoined cartilages of the 7th, 8th, and 9th ribs. It has a general downward trend and is normally slightly stepped in passing from one cartilage to the next. From the 9th cartilage the line generally passes to the 10th rib along a tendinous thickening of the intercostal endothoracic fascia. Thereafter, it crosses the inner

surfaces of the ribs obliquely, and bridges the intercostal spaces by tendinous thickenings.

There is no gross stepping as the line passes from one rib to the next. Distortion of the line of origin may occur in two ways, and each is associated indirectly with an increased incidence of liver grooving.

(a) It occurs when the chest is deformed, whether from skeletal malformation or disease, paralytic or postural muscular imbalance, or from chronic disease of the thoracic organs of a duration indicated by such terms as chronic fibrosis and emphysema. In all these conditions the thoracic outlet becomes enlarged on one or both sides. The anterior part of the line arising from the conjoined cartilages then becomes wavy, irregularly serrated, and even recurved upon itself for short distances (Friedel). Flaring of the lower rib margin as in pulmonary emphysema or gross hepatic enlargement is particularly liable to cause this change.

(b) In contrast with the foregoing, the lateral part of the line of origin becomes coarsely serrated when the ribs become more vertically placed, (as in thin elderly females, and on the side of a scoliosis) or when the diaphragm takes up a more horizontal position (as in emphysema). The posterior part of the oblique line of attachment to the ribs then becomes tilted upwards and the tendinous intercostal bands pass nearly vertically down to the next rib. As this coarse serration is often seen radiologically, it is important to realize that it is not the cause of diaphragmatic band or fold formation, or of liver grooving, though the two are often present together. When both conditions are present in the same subject, dissection and transillumination of the diaphragm permits clear demonstration of the separate identity of each.

Band formation is the earliest morphological change which can consistently be discerned as the cause of liver grooving. It precedes folding. It is nearly always confined to the inner two thirds of the sternal muscular sheet, and is unrelated to the anatomical slips of origin or to subdivisions of the slips. There are certain inconstant but definite accompaniments: distortion or serration of the line of origin; an abnormally high or low position of the dome; abnormally oblique or horizontal ribs; scoliosis; kyphosis; pulmonary disease; obesity; abdominal compression or distention; and paralysis of the diaphragm. The factor common to all these is diminished functional activity of the diaphragm.

THE DIAPHRAGMATIC CHANGES ACCOMPANYING BOSS AND HUMP FORMATION.

Examination of the diaphragm in both these conditions discloses more than mere moulding to the shape of the under-lying liver. The muscle layer over the bulge is
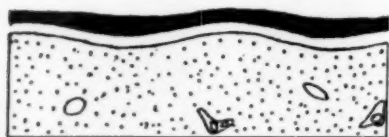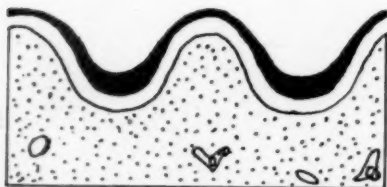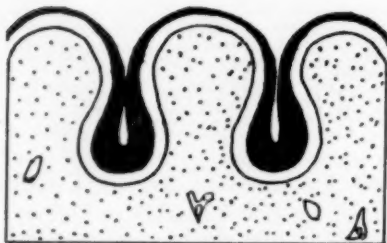
Stages in the development of liver grooves are represented diagrammatically:—

(A) Well developed thick and thin bands in the diaphragm with slight undulations of the surface of the liver.

(B) Diaphragmatic folds are developing.

(C) The folds are now large; the intervening areas of diaphragm are thin, and the liver is bulging up beneath them.

thinner than elsewhere. Where the sides of the liver bulge are demarcated by actual grooves, corresponding thick bands of muscle fibres are visible by transilluminating the diaphragm, and may form folds. The bands or folds are curved in agreement with the edges of the bulge. These bosses always lie beneath the sterno-costal muscular sheet. When large, they may appear to occupy the whole dome of a thin raised diaphragm, but even in such cases one finds that the stretching has occurred in the sterno-costal sheet predominantly. The central tendon is then tilted so that its upper surface faces backwards as well as upwards. These features point strongly to a primary role for the diaphragm in determining the existence and shape of the liver anomaly.

One of the most interesting features is the problem of explaining how a curved muscular band might produce a curved groove without straightening itself out in the process, and Weltz and Glauner denied the diaphragmatic hypothesis largely for this reason. The present series of specimens, in different stages of development, suggested that the grooves are produced in the following way:—

(a) A local area of relative weakening of the diaphragm allows protrusion upwards of a rounded boss of liver tissue.

(b) As this expands, the fibres at the edge become crowded together forming a band curving around each side of the boss. Other fibres which have slid down to the edge from the bulge itself may contribute to the band.

(c) The band then produces a curved marginal groove.

Thus, if we allow that upward protrusion of plastic liver tissue through an area of weakness is sometimes more important than downward indentation by a band of relative strength, the curvature of the grooves demarcating the lateral edges of the bosses can readily be explained, and the more closely the process approximates to a herniation. (It is possible that some of the antero-medial diaphragmatic herniae arise in this fashion.)

The rounded boss demarcated by highly curved grooves is almost a pure protrusion through a weak zone or band. The straight groove is almost a pure indentation by a strong band. Both factors are probably in operation in all cases, but not to an equal degree.
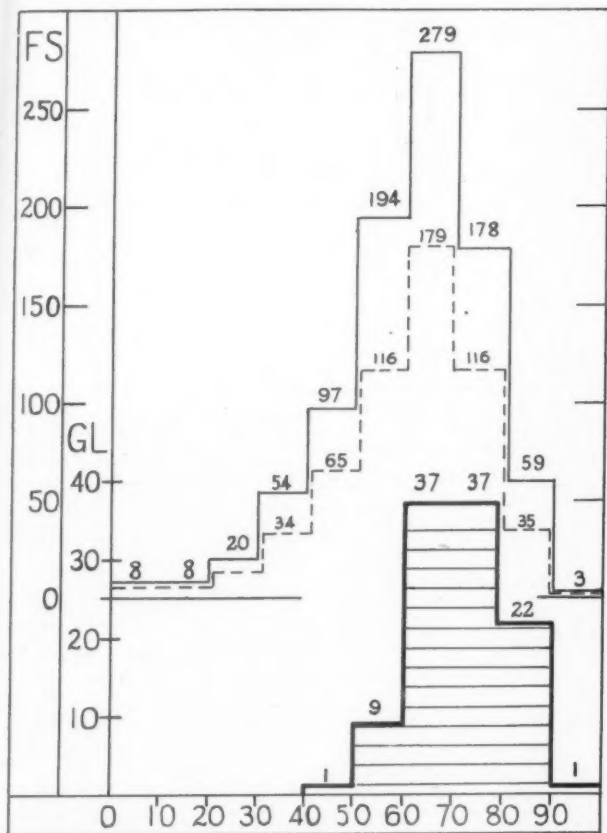
In the upper graph the full series of 900 autopsy subjects is shown according to the sex (males continuous line, females interrupted line). The abscissa represents decade of age, the ordinate (FS) indicates the number of subjects in each decade.

The lower graph shows the incidence of liver grooving using the ordinate GL. The greater incidence in elderly people is apparent.

The bossing deformity and the commoner straight grooves often co-exist in the same specimen. Moody found them together in 60 per cent. of his cases. Weltz and Glauner, however, did not observe a relationship in their material. In the present series, bossing was found in 15 per cent. of cases showing straight grooves. Both are of diaphragmatic origin, and are associated with the sterno-costal muscle sheet. Transitions between rounded bosses and the elongated vertical ridges in the typical grooved state are fairly common.

The hump deformity is merely a general protrusion of the liver under a weak costal sheet.

DIAPHRAGMATIC CHANGES ACCOMPANYING THE "CARDIAC IMPRESSION."

The central part of the upper surface of the liver is often found to lie at a lower level than the more lateral part of either or both lobes (Fig. VII). This has been observed by Friedel in cardiac enlargement but when there is an elevation of one or other side of the diaphragm, a heart of normal size may stabilize the level of the pericardial zone. The elevation may take the form of a general rise of the dome or of sternocostal bosses and humps.

The process is of immediate interest because the edge of the hepatic depression becomes demarcated by a distinct groove deeper than the rest of the impression, and the corresponding part of the diaphragm develops a local band of thickening. In this case it would appear that the sequence of events is (1) functional or local structural weakness of the dome relative to the sub-cardiac area of the diaphragm. (2) The dome becomes pushed up by the liver lateral to the heart. Then there is (3) a physical sliding of muscle fibres down the bulge to form a condensation where the bulge meets the stabilized part of the diaphragm. The stronger band (4) produces a groove, and may actually pull away from the pericardium so that a little pad of fat may ultimately intervene between the pericardium, pleura and diaphragm.

The sharpness of the edge of the cardiac impression progressively increases as the diaphragmatic band recruits more fibres from the raised dome and ultimately becomes a fold.

Cardiac stabilization in this manner accounts for the fact that bosses and humps never extend as far medially as the falciform ligament, and why their medial edge becomes demarcated by a muscular band of greater thickness than the adjacent sheet.

The cases in which grooves develop at the edges of the impression of an enlarged heart are of special interest because:—

(i) They demonstrate diaphragmatic segmentation occurring at the junction of weak and strong zones in adult life.

(ii) The reason for the irregularity of strength is apparent because the impression bears a constant relation to the heart.

(iii) The left groove is further from the midline than the right, and thus is related to a different anatomical slip of the diaphragm.

RELATION TO PATHOLOGICAL CHANGES IN THE DIAPHRAGM.

Careful investigation of the weight and microscopic condition of the diaphragm was not undertaken on the present material, but the impression was gained that it was thinner and lighter.

Fromme (1916) investigated diaphragmatic weight in relation to age and disease. It was found to be raised in states of cardiac enlargement and pulmonary fibrosis in which a cardiac element was present. It was reduced in emphysema, thoracic rigidity, old age, and when the liver showed grooves.

Strukow (1931) studied the microscopic condition of the diaphragm in 106 autopsy subjects of all ages, including several cases of accidental death and a few of liver grooving. The diameter of the muscle fibres was measured in all. Hypertrophy was demonstrable only when the heart was enlarged, and changed to atrophy when cardiac failure

began. General atrophy occurred in old age, pulmonary disease, and various other conditions. Small foci of necrosis inflammation and toxic change were frequent. In segmented diaphragms the fibres of the thick bands were of the same diameter as those of the thin bands. These observations exclude hypertrophy, and strongly suggest that segmentation develops in an atrophic diaphragm.

PART 2.

This section presents the age and sex incidence of typical hepatic grooving and the frequency of predisposing conditions observed in a series of nine hundred consecutive autopsies carried out in a general hospital over a period of sixteen months.

(A) Age and Sex Incidence.

The series comprised 338 females and 562 males, and its composition according to age groups is given in Table 1. The preponderance of adults, and of male subjects is a reflection of the sections of the community treated by the hospital (Fig. XV).

The incidence of liver grooving is shown in Table 2.

The incidence of grooving in males was 14 per cent., i.e., 79 cases in 562 subjects and in females 8.3 per cent., i.e., 28 cases in 338 subjects. The overall incidence was 11.9 per cent.

The importance of age as a factor determining the process of grooving emerges very clearly.

The average age of subjects with grooves was higher than that of the total series (Fig. XV).

Thus, out of 59 subjects in the 80-89 age group, 22 or 37.3 per cent. were affected.

Grooving has been reported in the newborn and in children but is rare. Dr. J. W. Perry, Pathologist to the Children's Hospital, has not encountered a case in 200 recent autopsies on children under 14 years of age.

(B) Pulmonary Disease.

In each case of hepatic grooving, the lungs were carefully examined for chronic disease. In many doubtful cases they were fixed prior to cutting by intratracheal instillation of a solution containing 12 per cent. of commercial formalin.

TABLE 1.

AGE AND SEX INCIDENCE OF TOTAL AUTOPSY CASES.

Age Group (years)	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	TOTAL
MALES	5	4	14	34	65	116	179	116	35	2	562
FEMALES	3	4	6	20	32	78	100	62	24	1	338
TOTAL	8	8	20	54	97	194	279	178	59	3	900

TABLE 2.

AGE AND SEX INCIDENCE OF CASES SHOWING LIVER GROOVES.

Age Group (years)	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	TOTAL
MALES	—	—	—	—	1	6	24	27	20	1	79
FEMALES	—	—	—	—	—	3	13	10	2	—	28
TOTAL	—	—	—	—	1	9	37	37	22	1	107

The lungs were considered to be within normal limits in 20 of the 79 males, i.e., 25.3 per cent. and in 17 of the 28 females, i.e., 50.7 per cent.

The commonest lesions encountered were emphysema, pulmonary fibrosis, pulmonary tuberculosis, pleural scarring and adhesions, primary carcinoma of the lung, and bronchiectasis.

Clearly, pulmonary disease is a major predisposing factor in males, but is an infrequent one in females. When subjects with pulmonary disease are excluded, the incidence of liver grooving is actually higher in females (5 per cent.) than in males (3.6 per cent.).

(C) Liver Size.

The absolute or relative size of the liver was not found to influence the appearance of grooves. The range of liver weight did not differ from that of the series as a whole.

(D) Thoracic Deformity.

Although grooving appears to be commmoner when the thoracic cage is distorted, it cannot be related to a trend in any one direction. Thus the chest may be barrel-shaped, with a wide subcostal angle, flared lower margin and horizontal ribs, or conversely of small size, with a narrow subcostal angle and oblique ribs. Similarly, the dome of the diaphragm may be flat or highly arched. Weltz and Glauner found grooving on the contralateral side in mediastinal shift. It also occurs on the homolateral side.

(E) State of Nutrition.

Grooves may be found in the presence of obesity or emaciation.

PART 3.

DISCUSSION AND CONCLUSIONS.

The views of some of the authors who have written on the question of liver grooving may be classified thus:—

1. That the grooves are caused by diaphragmatic folds.

A. Developing post-natally.

This is expressed or implied opinion of many of the adherents of:—

(a) The constriction hypothesis (Cruveilhier and other French observers).

This doctrine, in its most complete form, states that abdominal constriction by tight lacing or distension of the abdomen by a large liver, obesity, ascites, or tumour, causes a series of changes such as flaring of the lower ribs, widening of the subcostal angle, visceroptosis, "foie bombé," and liver grooves. The diaphragm, thrown into folds by thoracic deformity, moulds the liver.

(b) The respiratory disturbance hypothesis (Fromme, Friedel, Thomas, Assmann, Weltz and Glauner). This view holds pulmonary disease and thoracic deformity as the chief causes of diaphragmatic folds.

(c) Adhesion hypothesis. Moody considers that in some cases folds might occur by contraction of pleural or peritoneal adhesions involving the diaphragm.

B. Developing ante-natally.

Eleven cases of grooved liver in the foetus or newborn have been recorded: Orth (1 case) (Moody); Chiari (1899) (3 cases); Moody (3 cases); Westenhöfer (1 case); Kawata (1929) (2 cases); Woerner (1927) (1 case). Westenhöfer and Kawata doubted the role of the diaphragm. Of Chiari's cases, two had gross thoracic deformity, but in all there was a close correspondence between thin areas in the diaphragm and ridges of liver tissue. This also applied to one of Moody's cases and to that reported fully by Woerner. It is clear that congenital weaknesses of the costal sheet sometimes occur, and give rise to grooves of the liver similar to those of adults.

2. That the grooves are intrinsically hepatic.

According to this view, the liver may undergo a crumpling of its upper surface when there is a disproportion between its size and the available room. This may occur before or after birth.

(a) Before birth. Foetal cases of liver grooving in which diaphragm was considered normal were recorded by Moody and Westenhöfer. Kawata also supported the crumpling hypothesis for foetal cases.

(b) After birth. The possibility that constriction produces crumpling, which in turn results in secondary changes in the diaphragm, was implied by some authors during the nineteenth century, and has been supported by Moody and Westenhöfer.

3. *That the grooves are of costal origin.*

Several authors have concluded that in conditions causing difficult respiration, the lower ribs are powerfully drawn inwards by the abdominal muscles and give rise to the sagittal grooves.

This wide divergence of opinion has probably arisen from the numerous exceptions which can be adduced to each hypothesis. Evidence of constriction is often absent and gross examples are now rarely seen. Grooving may occur in people with normal lungs and a normal thoracic case. An exclusive foetal origin is unlikely when the rarity of the condition in children and young adults is compared with its high incidence in octogenarians..

In the present series of cases, an accurate co-relation between the thickness of the diaphragm and the shape of the underlying liver was always observed. The diaphragmatic changes were accepted as primary because crumpling by external pressure of a plastic organ such as the liver is difficult to understand unless a difference in the growth rates of the surface and core is present as in the developing brain.

One is led to seek in the diaphragm itself for an explanation. There is no evidence to support the claim that the bands are due to patchy hypertrophy. The average diaphragmatic weight is reduced (Fromme). The fibre diameter in the thick bands is no greater than in the thin areas (Strukow). The remaining possibility is that any weak patch developing in the sterno-costal sheet of either side gradually becomes a longitudinally orientated weak band which is slightly bulged by the intra-abdominal pressure. Bulging induces fibre rearrangement, so that the stronger bands grow at the expense of the weak bands. When this segmentation is sufficiently advanced, noticeable grooving of the liver begins.

The initial weakness might be organic or functional. It is very rarely congenital. The microscopic findings of Strukow and others indicates that the diaphragmatic muscle is highly susceptible to local damage and destruction in general infectious processes, in inflammation of adjacent organs, in cardiac failure and in old age alone. Perhaps as simple a matter as a bad diaphragmatic breathing habit might sometimes be sufficient.

Local areas of transient functional weakness or toxic change might initiate the sequence. Pneumothorax, phrenic paralysis, and experimental strychnine poisoning have been reported as causes.

The development of weak spots which may be temporary or permanent, organic or functional in the thin sterno-costal sheet is the probable starting point of the condition. It then becomes possible to explain the age incidence, the random distribution of grooves with respect to anatomical bundles, the inconstant relationship to diaphragmatic height, liver size, abdominal distention or compression, stigmata of lacing, dyspnoea, thoracic shape or costal obliquity. Each of these is a predisposing cause important in the individual case but none is of universal occurrence. The most potent predisposing conditions are those in which there is advanced disuse atrophy, namely, chronic pulmonary disease, thoracic deformity and a raised abdominothoracic pressure gradient. The thoracic factors are commoner in males and usually produce parallel grooving; the abdominal factors are commoner in females and often produce bosses or humps, alone or in combination with parallel grooves.

RADIOLOGICAL ASPECTS OF THE DIAPHRAGMATIC DEFORMITIES.

The normally smooth uniform contour of the diaphragmatic shadow is sometimes segmented into two or more overlapping arcs. Each arc forms a regular curve. A double contour is commoner than a multiple one. The radiological incidence of diaphragmatic deformity is lower than that found at autopsy, probably because the angle of incidence of the beam used in the conventional view of the chest is not the most favourable one for demonstrating the antero-superior and lateral surfaces of the liver.

The arcs may vary in prominence in different phases of respiration, but it is unlikely that the grooves and folds on the right side actually alter in size. Respiratory movement merely changes the segment of diaphragm projected. Similar variation occurs when the patient or the tube is moved.

Respiratory alterations of the depth of folds overlying the stomach might be possible.

(1) The Multiple Arc Contour.

This appearance is due to the presence of several long parallel grooves as commonly seen at post-mortem. The arcs overlap because they correspond to elongated ridges directed obliquely downwards, forwards and laterally, and which are therefore partially superimposed in an antero-posterior view.

Assmann (1934), ascribes multiple arc formation to individual muscle bundles laterally placed, and Shanks, Kerley and Twining (1938) speak of "local contraction of slips of origin of the diaphragm." Neither of these statements is strictly accurate.

(2) The Double-arc Contour.

This appearance is commoner radiologically than multiple arc formation, but is similar inasmuch as each of the segments is a smooth regular curve. Thomas (1922) investigated the post-mortem condition of the liver and diaphragm in cases which had shown this anomaly. His description identifies this as the deformity described above under the term "boss" formation. It is noteworthy that the less common pathological finding should be the more common radiological finding. Two explanations of this are possible.

(a) The angle of the X-ray beam may be more favourable for demonstrating the medial boss than the laterally placed grooves.

(b) Only one groove may be visualized although more are actually present.

Thomas concluded that the anomaly was due to a diaphragmatic fold produced by the muscular slips arising from the eighth and ninth costal cartilages which, being longest, contact most strongly. Assmann, Singer and Boikan, and Ballon have granted this statement limited approval, but it is misleading for these reasons:—

(a) The slips from the 8th and 9th cartilages constitute a wide portion of the muscle, and cannot be grouped collectively as a strong area. Two or three thick and thin bands may be present in this part.

(b) Segmentation into thick and thin bands, the earliest change related to the anomaly, is independent of anatomical slips and occurs in the inner two-thirds of the muscular sheet.

(c) There is no evidence to show that a long slip contracts more strongly than a short one or that diaphragmatic contraction is unusually forceful in the circumstances associated with the anomaly. On the last question the pathological evidence points to diminished activity and even atrophy.

(3) Visualization of the Costal Slips.

The slips arising from the ribs, especially the 10th and 11th, are sometimes visible on the chest film. They have a straight upper border, may be traced accurately to the ribs, and run slightly upwards and inwards forming a set of steps. As stated earlier, increased costal obliquity or a horizontal position of the diaphragm exaggerates the serration of the lateral part of the line of origin. There is no evidence for the suggestion of hypertrophy put forward by Singer and Boikan, and no reason was offered why the portions arising from ribs should undergo hypertrophy whereas the portions arising from the intervening intercostal spaces should not. Furthermore, the total diaphragmatic weight is usually decreased, and the only significance of the condition is that in a general way it indicates atrophy.

(4) The Tenting Deformity.

A localized rounded upward extension of the medial part of the diaphragmatic shadow was described by Matson (1922). He suggested that inflammatory rigidity and shortening of a bronchus might be the cause. No evidence bearing on the question was obtained from the present investigation. Matson's illustrations suggest atypical double-arc formation.

(5) The Saucer Deformity.

Middleton (1927) described sharply-peaked upward extensions of the diaphragmatic shadow. They were transient and were accompanied by acute pulmonary infections. No example of a diaphragmatic deformity of this type was observed.

CONCLUSION.

When assessing the significance of abnormal diaphragmatic shadows, it may be safely assumed that only the first three entities rest on a sound pathological basis. All of these are chronic states indicative of decreased diaphragmatic function but, in themselves, are of little symptomatic importance.

SUMMARY.

1. The deformities of the antero-superior surface of the liver caused by the costal part of the diaphragm are reviewed under the terms "diaphragmatic grooves," "bosses" and "humps."

2. In a series of 900 consecutive adult autopsies the incidence of grooving was found to be 11.4 per cent. The incidence of predisposing conditions is presented.

3. The aetiology of the diaphragmatic changes is discussed.

4. A brief evaluation of radiological appearances is appended.

REFERENCES.

ADAMI, J. G., and NICHOLLS, A. G. (1911), "The Principles of Pathology," Philadelphia, Lea and Febiger.

ASSMANN, H. (1934), "Die Klinische Röntgendiagnostik der inneren erkrankungen," Teil I, Berlin, F.C.W. Vogel.

BALLON, H. C. (1935), J. Thoracic Surg., vol. 4, page 573.

CHIARI, H. (1900), Verh. dtsch. path. Ges., vol. 2, page 107.

CRUVEILHIER, J., et SEE, M. (1874-6), "Traité d' Anatomie Descriptive," Paris. P. Asselin.

FRIEDEL, A. (1922), Z. Ges. Anat., vol. 64, page 445.

FROMME, H. (1916), Virchow's Arch., vol. 221, page 117.

KAUFMANN, E., trans., REIMANN, S. P. (1929), "Pathology for Students and Practitioners," New York. Blakiston.

KAWATA, N. (1929), Frankf. Z. Path., vol 38, page 266.

LANE, W. A. (1888), J. Anat. and Phys., vol. 22, page 593.

MATSON, R. C. (1922), Amer. J. Med. Sci., vol. 163, page 826.

MIDDLETON, W. S. (1927), Amer. J. Roentgenol., vol. 17, page 630.

MOODY, R. O. (1905), Bull. Johns Hopkins Hosp., vol. 16, page 364.

SHANKS, S. C., KERLEY, P., TWINING, E. W. (1938), "A Text-book of X-ray Diagnosis," London. H. K. Lewis & Co. Ltd.

SINGER, H. A., and BOIKAN, W. M. S. (1933), Amer. J. Roentgenol., vol. 29, page 600.

STRUKOW, A. I. (1931), Virchow's Arch., vol. 282, page 643.

SYMINGTON, J. (1898), 'Quain's Elements of Anatomy," London. Longmans, Green and Co.

THOMAS, E. (1922), Dtsch. med. Wschr., vol. 48, page 688.

WELTZ, G. A., and GLAUNER, R. (1933), Virchow's Arch., vol. 290, page 705.

WESTENHÖFER, V. A. (1920), Virchow's Arch., vol. 227, page 172.

WOERNER, E. (1927), Anat. Anz., vol. 63, page 105.

CASE REPORTS.

A COMPLICATED CASE OF OTITIC CEREBRAL ABSCESS.

By R. S. HOOPER.

Melbourne

FOLLOWING the introduction of power-ful chemotherapeutic agents and their local application in infections of the central nervous system, it is only to be expected that among those patients whose life is pro-longed, but not saved, by their use there will be a greater range of late complications than would usually follow the normal unhindered progress of the disease to its fatal termi-nation.

The case to be described presented a wide range of complications which caused con-siderable difficulty in diagnosis and treat-ment. Following an otitic infection the patient developed meningitis and ventricu-litis, an intra-cerebral abscess, thrombosis of the lateral sinus and thrombophlebitis of the posterior anastomotic vein. Finally, an obstructive hydrocephalus occurred follow-ing the development of a membrane in the aqueduct of Sylvius.

Although the precise relationship between these conditions may be problematical, they had to be differentiated in order that appro-priate measures might be taken. The failure to do this completely, and at a sufficiently early stage, had an adverse influence upon the ultimate outcome of the group of com-plications presented.

CASE REPORT.

One week prior to admission to hospital in January, 1948, a boy of 12 years complained of left-sided earache and deafness. Two days later there was a purulent discharge from the left ear. On the day before admission to hospital the child became listless and feverish, and the following day became delirious and later stuporose. After admis-sion to hospital he had several Jacksonian seizures and remained unconscious.

Examination at the time of admission revealed a purulent discharge from both ears, some weak-ness of the right limbs as compared with the left; the abdominal reflexes were absent and the right plantar response was extensor. A lumbar puncture at this time revealed clear cerebrospinal fluid at normal pressure. Queckenstedt's test was not recorded.

After the cessation of the seizures the patient's conscious state improved, but he still remained apathetic and drowsy, complaining intermittently of headache. The temperature was swinging. One week after admission the headache increased and neck stiffness was present. Lumbar puncture now revealed cerebrospinal fluid at a pressure of 280 mm. which later yielded cultures of an atypical bacterium coli and an anaerobic streptococcus. Later, on the same day, bilateral posterior parietal burr holes were made, while through a third burr hole in the left temporal region thin foul smelling pus was obtained from an abscess in the left temporal lobe. Two millilitres of thorotrast were instilled into the abscess cavity (Fig. I.).
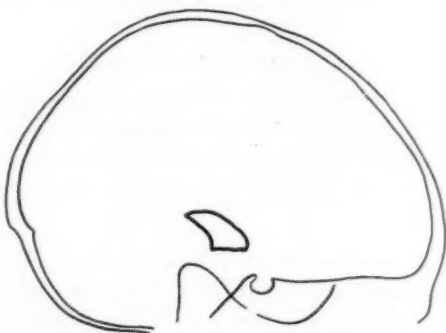

FIG. I. The initial pyogram of the otitic abscess in the temporal lobe.

For the next ten days pus was aspirated from the abscess cavity which was then filled with solu-tions of penicillin and streptomycin. These agents were also given daily by intra-thecal injection while intra-muscular penicillin and oral sulphadiazine were also given. Although the abscess cavity rapidly became reduced in size, the cerebrospinal fluid remained turbid and the neck stiffness continued.

On the twenty-fourth day after the onset of the condition a simple mastoidectomy was carried out on the left side. The mastoid process was found to be hard, sclerotic and acellular. No purulent material was found within the process or in re-lation to the dura exposed in the middle fossa. The meningitis continued and in the week following the left mastoidectomy a difference in the Quecken-stedt test was found for the first time, a brisk rise being found on compressing the right jugular vein, while no appreciable response was obtained on the left side. The swinging temperature, stupor and neck stiffness continued, and at infrequent intervals the ventricular and lumbar cerebrospinal fluid would produce positive cultures of the initial organisms.

ventriculograms showed a progressive dilatation of the lateral ventricles (Fig II.). As no further positive cultures were obtained from ventricular or lumbar cerebrospinal fluid it was thought that a severe chemical meningitis had resulted from the prolonged period of chemotherapy. After the seventh week of the illness intra-ventricular therapy was discontinued when the ventricular fluid contained 6,100 polymorphonuclear leucocytes per cmm. Within three days both the ventricular and lumbar fluids were macroscopically clear, but a significant disparity was found in the cell counts of these fluids. The ventricular fluid contained 410 leucocytes per cmm. while the lumbar fluid contained only 35 cells.

Although the cerebrospinal fluid had cleared, the neck retraction and opisthotonus continued. At times breathing would become laboured and the pulse rate rapid. During these attacks the high intra-ventricular pressure was released by needling. Respirations became quieter and the pulse rate slower, but no change in the degree of opisthotonus was produced. Needling of the ventricle became necessary more often as the attacks became more frequent. At the same time, the temperature, which had fallen somewhat after the meningitis had cleared up still continued to swing irregularly and rigors occurred at intervals. Blood cultures were carried out with negative results.

At this stage 1 cc. of phenolsulphonephthalein was injected into the lateral ventricle, but no dye was detected in the lumbar fluid or in the urine during the next twenty-four hours.

Ten weeks after the onset a ventriculogram was carried out, with more complete filling of the ventricles. A further increase in the size of the lateral and third ventricles was noted (Fig. II.). There was gross dilatation of the left frontal horn and the right temporal horn as compared with their counterparts of the opposite ventricle. The third ventricle was central in position but was at least 2.5 cm. in width and lapped over the posterior clinoid process. The posterior end of the ventricle was well outlined by gas but in spite of prolonged positioning no gas passed out of the third ventricle down the aqueduct.
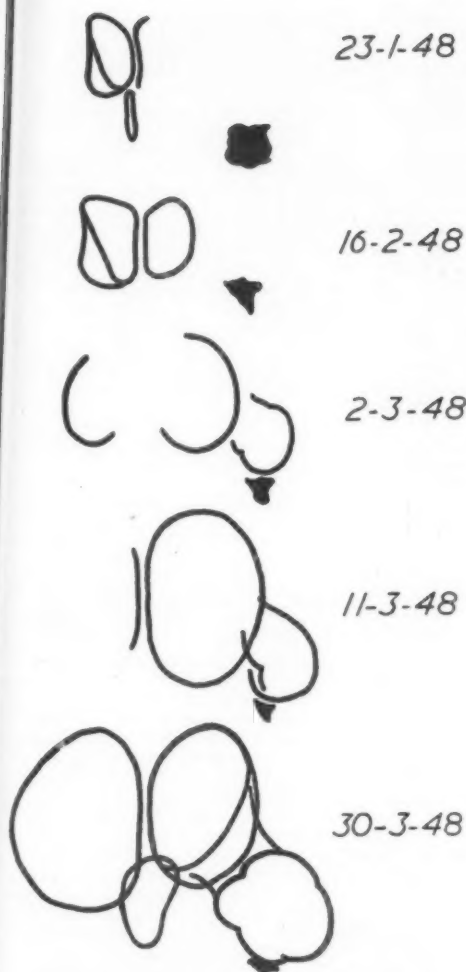

FIG. II. Tracings of serial ventriculograms showing the progressive dilatation of the ventricles which became more rapid during the last month of the illness.

On the thirty-seventh day of the illness the right mastoid process was explored, but the changes found were insignificant. The right lateral sinus appeared normal. The left lateral sinus was then explored. The covering bone appeared normal, as did the wall of the sinus. The sinus was then needled and fresh blood was obtained, from which no organisms could be cultured. In spite of this some blood stream infection was suspected and the dosage of penicillin was increased till 60,000 units were given daily into the cerebrospinal fluid pathways and 100,000 units were given intramuscularly every three hours. In spite of this therapy the meningitis continued; the degree of neck retraction and opisthotonus was gross, while
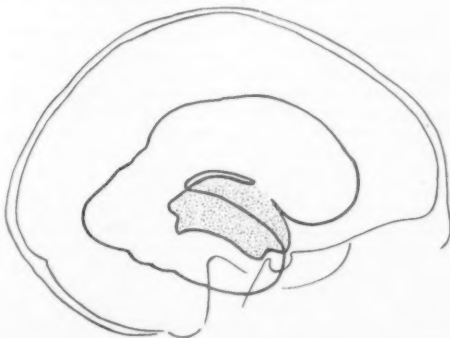

FIG. III. Tracing of the ventriculogram to show dilatation of the lateral and third ventricles. The upper end of the aqueduct is funnel-shaped and no gas could be made to pass down to the fourth ventricle.

To confirm the presence of a block in the aqueduct an encephalogram was carried out. Air outlined the cisterna magna, the fourth ventricle and the proximal part of the aqueduct (Fig. III.). The distal end of the aqueductal shadow, just above its commencement was slightly concave. Gas ascended along the basal cisterns into the lower part of the inter-peduncular cistern. The upper level here was sharply cut off as if the upward passage of air was blocked in the *incisura tentorii*. No gas passed further distally.

Immediately following this procedure a fine catheter was inserted through a frontal burr hole and into the frontal horn of the lateral ventricle, but there was still no reduction in the degree of opisthotonus. Three days later a ventriculocisternostomy was carried out. A fine catheter, after being introduced into the lateral ventricle, was brought down under the scalp to a sub-occipital decompression and placed in the cisterna magna. There appeared to be no herniation of the cerebellar tonsils and the cisterna was quite capacious and the arachnoid membrane surprisingly clear.
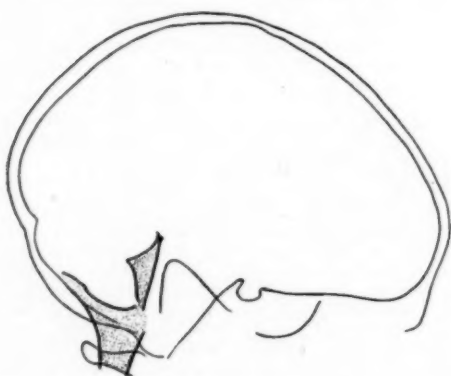

FIG. IV. Tracing of encephalogram to show a capacious cisterna magna and a normal fourth ventricle. At the site of the obstruction, the upper limit of the aqueduct appears concave.

Following this procedure there was an immediate reduction of both the neck retraction and the opisthotonus. For the first time for some weeks the child could be nursed in the supine position. The lumbar cerebrospinal fluid was lightly bloodstained and the pressure was raised over 200 mm. The child's general condition and state of consciousness appeared greatly improved.

However, on the third day after operation, right-sided epileptic convulsions commenced and later became generalized. The convulsions became more frequent and attempts to control them by paraldehyde only appeared to increase the pulmonary oedema. The temperature became elevated. The seizures continued, and were difficult to control even with large doses of intravenous pentothal. After continuing intermittently for two days, a more prolonged seizure occurred during which respiratory failure occurred and the child died.

Post-mortem examination:

After removal of the calvarium, it was at once apparent that there was a thrombosis of the left lateral and sigmoid sinuses, which partially occluded this channel from the torcula to the jugular foramen. In the sigmoid sinus a well-defined mural thrombosis was seen. This was quite adherent to the antero-medial wall of the sinus. A cross section of the sinus here showed a partially organized thrombosis, greenish-yellow in colour, and partially re-canalized. In the transverse sinus the thrombosis appeared to vary in age, being in part quite firmly attached to the wall of the sinus and in part easily separated. No evidence of suppuration was seen, and little inflammatory reaction was seen in the outer wall of the sinus. At the junction of the sigmoid and transverse sinuses the large posterior anastomotic vein was seen to be completely thrombosed. The dura over the temporal bone appeared normal in texture though there was one fine thread-like, vascularized adhesion extending from the dura overlying the arcuate eminence to the under surface of the temporal lobe.

Examination of the petrous portions of each temporal bone showed sclerosis of bone around the mastoidectomy openings but no definite areas of osteomyelitis.

The brain showed no evidence of inflammatory exudate or arachnoidal thickening which could be attributed to the prolonged meningitis. The convolutions of the brain were moderately flattened. Extending from the posterior end of the Sylvian fissure to the lateral sinus on the left side was the completely thrombosed posterior anastomotic vein. The thrombosis extended into some of the neighbouring channels, and around the vein there was a definite vascular reaction with dilatation and tortuosity of the small vessels.

A medial sagittal section through the whole brain showed a dilated third ventricle. At the entrance to the aqueduct there was a thin membrane, less than 1 mm. in thickness, which completely occluded the aqueduct at this level (Fig. V.). Below the membrane the aqueduct appeared patent and without further abnormality.

Coronal sections through the left hemisphere showed a dilated lateral ventricle, the dilatation of the temporal horn being much greater than the remaining portion. The healed cerebral abscess lay on the infero-medial aspect of the wall of the ventricle, appearing as a small area of fibrosis and pigmentation 6 mm. across, and containing a small central cavity. The internal surface of the ventricle showed some slight roughening of the ependymal surface and sub-ependymal pigmentation. In the occipital horn of the lateral ventricle there was a noticeable thickening of the ependymal lining which, in some places, exceeded 2 mm. in thickness.

Histological Examination:

The lumen of the sigmoid sinus was partially occluded by an extensively organized blood clot, approximately half of the lumen remaining patent
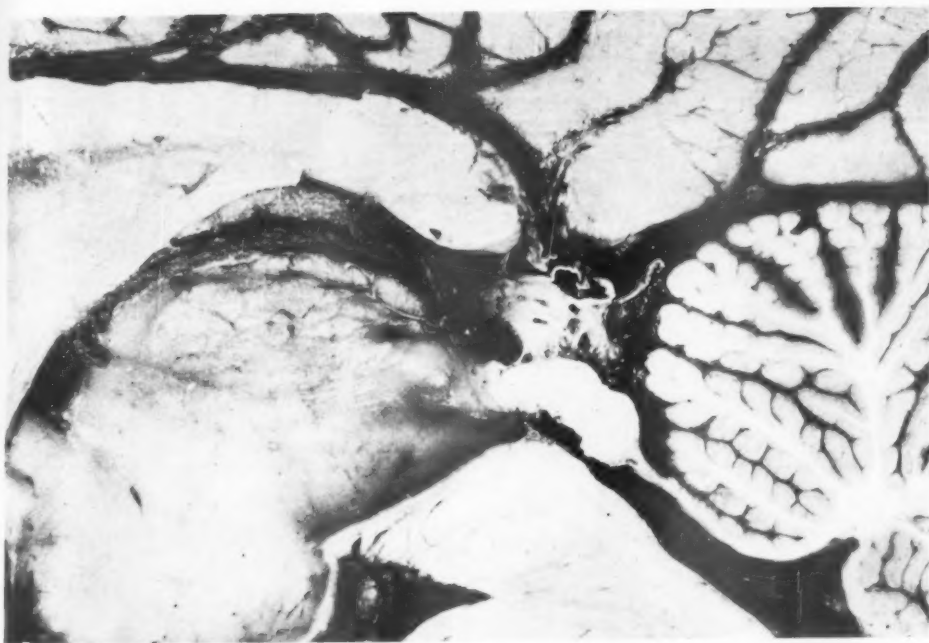
FIG. V. A sagittal section through the brain revealing a dilated third ventricle and the membrane across the upper end of the aqueduct of Sylvius.

(Fig. VI.). The initial lining showed some proliferation of the endothelium, while the external surface of the thrombosis had been completely covered by a layer of endothelial cells. Canalization of the clot had taken place around its periphery.
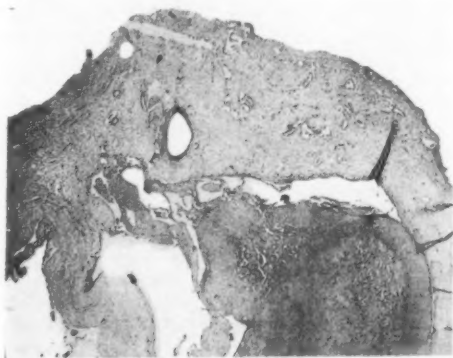

FIG. VI. Low power photomicrograph of the mural thrombus in the sigmoid sinus.

The posterior anastomotic vein was completely occluded with partially organized blood clot (Fig. VII.). A moderate degree of endothelial proliferation was seen on the medial or cerebral side of the lumen. In two areas of the section the clot appeared to be breaking down and circumscribed areas were packed with polymorphonuclear leucocytes and macrophages, the latter being stuffed with pigment. In the surrounding sub-arachnoid space there was a considerable leptomeningeal reaction, with proliferation of fibrocytes and accumulation of polymorphonuclear leucocytes and small round cells. There was also a considerable proliferation of small vessels. These changes were limited to the immediate vicinity of the thrombosed vessel.

The membrane which formed a complete septum across the aqueduct (Fig. VIII.) was composed of a loose membrane of fibrous tissue containing small round cells, macrophages and a few polymorphonuclear leucocytes. The surface of the septum was composed of flattened fibrocytes; ependymal cells were not seen. At the peripheral attachment of the septum were a number of thin-walled vessels. The walls of the adjacent aqueduct showed a moderate amount of fibroglial proliferation, the surface being thrown into folds or nodules. Although some fragments of ependymal lining were present along the length of the aqueduct, the lining was mainly formed by fibroglial cells.

The abscess cavity was reduced to a small triangular mass of fibrous tissue situated immediately below the wall of the ventricle. This area contained numerous macrophages in which were seen granules of thorotrast. The adjacent portion of the choroid plexus was flattened and in part

obscured by subependymal glial proliferation. The ependymal lining of the ventricle was absent over considerable areas.
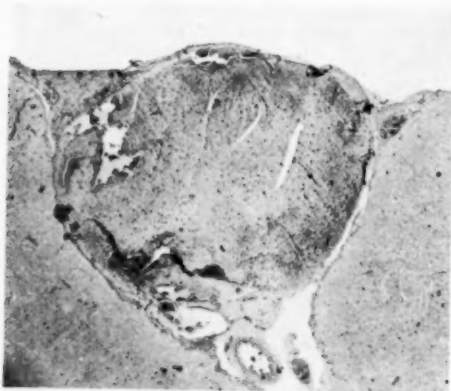

FIG. VII. Low power photomicrograph of the posterior anastomotic vein, showing the thrombophlebitis and surrounding leptomeningitis.

DISCUSSION.

Although the sequence of these complications cannot be determined with complete assurance, it seems likely that the otitis media and mastoiditis were followed by an osteomyelitis of the petrous portion of the temporal bone. When the bone in the neighbourhood of the sigmoid sinus was involved a mural thrombosis occurred, which extended up and down the sinus and along the inferior anastomotic vein. The cerebral abscess was probably a result of the last process. Courville and Nielson (1934) state that this is the usual mode of progress when an abscess is associated with lateral sinus thrombosis. Whether the actual spread of infection was peri-vascular or intra-vascular cannot be determined as active inflammatory changes were seen in both situations. During this advance a leptomeningitis and ventriculitis was produced and after some weeks duration the septum across the aqueduct and the ependymal thickening of the posterior portions of the lateral ventricles remained the only sequelae after the prolonged period of active chemotherapy.

An alternative explanation is that the thrombophlebitis of the cortical vein followed the abscess formation in its "watershed" and at its distal end the thrombotic process spread to the lateral sinus to produce the mural clot, the meningeal reaction occurring at the same stage as the abscess formation.

FIG. VIII. Low power photomicrograph of the membrane across the aqueduct.

Whichever view is accepted as probable, it is unlikely that there would be any radical change in the course of the condition or upon the treatment which would have been instituted at any particular stage. Thus, it would seem advantageous to confine the discussion to the thrombosis of the vein and sinus, the intra-cerebral abscess and the obstructive hydrocephalus.

Sinus thrombosis and thrombophlebitis of the cortical vein.

There can be little doubt concerning the pathological relationship between these conditions which were suggested clinically by the high swinging temperature, the convulsive phenomena and the results of jugular compression on the lumbar cerebrospinal fluid pressure. The tentative diagnosis of thrombophlebitis and sinus thrombosis made at this stage was upset by the normal appearance of the sinus at operation and by the fact that aspiration produced negative

results, but apart from opening the sinus widely during the mastoid operation no positive evidence was obtainable. It must be remembered also that there was a bilateral otitic infection and the first sinus opened may not have been the only one so affected. Although angiographic studies were considered at one stage, it was felt that the failure of one particular group of cerebral veins to fill would not carry sufficient weight for the ligation and drainage of the sinus when it had already been proved to be patent. Thus, the difficulty in diagnosing a mural thrombosis of the lateral sinus would appear considerable. No fibrinogen B. estimation was carried out on the blood from the patient. Phillips (1948) suggests that an increase of fibrinogen B. concentration may be diagnostic in cerebral thrombophlebitis. That such a condition was probable was suggested by the convulsive phenomena and by the localized dilatation of the temporal horn of the ventricle.

Certainly the possible significance of fibrinogen B. in the blood was not appreciated at this time; nevertheless the use of heparin or dicoumarol were considered, but in view of the necessity for frequent lumbar and ventricular punctures the risk appeared considerable. A previous similar case treated in this manner had survived a suppurative sinus thrombosis and meningitis only at the expense of a paraplegia caused by an extrathecal haemorrhage following a lumbar puncture.

The intra-cerebral abscess.

This condition proved to be the least of the therapeutic problems and the specimen showed how adequately the abscess could be collapsed and healed by intermittent aspiration and instillation of antibiotic agents.

As so frequently happens, no direct communication could be established between the abscess and the inflammatory process in the ear or with the thrombosed venous channels.

The obstructive hydrocephalus.

The dilatation of the lateral ventricles which occurs during the acute stage of meningitis is recognized to be due to obstruction to the flow of cerebrospinal fluid by the accumulation of inspissated pus or inflammatory exudate (Russell, 1949 and

Cairns, 1949). This accumulation may block the openings of the fourth ventricle into the basal cistern or it may occlude the narrow aqueduct. But a search of the literature has failed to reveal a similar case when the exudate has become converted into a granulation tissue membrane after the meningeal infection has become controlled. Dorothy Russell (1949) describes one case of septum formation in the aqueduct and refers to three additional cases in the literature. A further case is described by Scheuerman and Groff (1948) when a membrane was encountered at the lower end of the aqueduct at an operation for a suspected posterior fossa neoplasm. These cases appear to be due to congenital mal-development, but it is conceded by Dorothy Russell that such a membrane may be inflammatory in origin.

The nature of the septum leaves little doubt that it has followed the organization of fibrinous exudate deposited around the upper end of the aqueduct.

The diagnosis of such a condition was suggested by the decerebrate state of the patient; a rapid dilatation of the lateral ventricles and a failure of the dye introduced into the lateral ventricles to appear in the lumbar theca. The exact location of the obstruction can be confirmed only after ventriculography or encephalography.

The possibility of such an obstruction has an important bearing upon treatment. In cases of severe purulent meningitis it is essential to prevent the deposition of the fibrino-purulent exudate in the posterior portions of the ventricles or basal cisterns. Such a deposition is enhanced by gravitational effects, the exudate tending to sediment if the head is immobilised in one position. To minimize this risk the position of the patient's head should be moved repeatedly.

Once the existence of a post-meningitic aqueduct block is established and infection has been controlled, there can be little doubt concerning the need for some short-circuiting procedure. The introduction of a Torkildsen tube appears preferable to a direct attack on the membrane as described by Scheuerman and Groff (1948). The former procedure is likely to be successful if the meningitis is controlled and the *cisterna magna* free of inflammatory exudate.

SUMMARY.

A case presenting multiple intra-cranial complications following otitis media is described. At autopsy sinus thrombosis, cortical thrombophlebitis, intra-cerebral abscess and a membranous obstruction of the aqueduct were found.

The clinical features of these conditions are discussed in relation to diagnosis and treatment.

REFERENCES.

CAIRNS, Sir Hugh (1949), *Brit. Med. J.*, vol. 1, page 969.

COURVILLE, C. B. and NIELSON, J. M. (1934), *Arch. Otolaryngol*, vol. 19, page 451.

PHILLIPS, G. (1948), *J. Neurol, Neurosurg. Psychiat.*, vol 2, page 263.

RUSSELL, Dorothy S. (1949), "Observations on the pathology of hydrocephalus," London Medical Research Council. Report No. 265.

SCHEUERMAN, W. G. and GROFF, R. A. (1948), *J. Neurosurg.*, vol. 5, page 399.

THE INTERINNOMINO-ABDOMINAL OPERATION.

By MILROY PAUL.

Professor of Surgery, University of Ceylon.

THE first interinnomino-abdominal operation was performed by Billroth in 1889. Up to the end of 1948, 170 cases had been listed in the literature. The list is a long one, and yet each interinnomino-abdominal operation remains an event, for the operation is still the province of the few who have been enthusiastic enough to master the technique of this formidable procedure. Although the operation is only called for in a small group of patients who have gross tumours at the root of the lower limb, there are still too many patients not operated on because of insufficient appreciation of the possibilities of this amputation. The writer had the privilege of watching Sir Gordon Gordon-Taylor perform three interinnomino-abdominal operations at the Middlesex Hospital in 1949, and the present case is the result of these very stimulating contacts with this great surgeon, whose writings and work have been largely responsible for the present position of the operation.

CASE REPORT.

Mrs. W. A. D., aged 52, was admitted to the General Hospital, Colombo, on 20th Oct., 1948, on account of a large tumour of the left buttock. Three years previously, the patient had had pain in the left knee which, however, showed no abnormality. A year later there was severe pain with every movement of the left hip, preventing walking. This pain also radiated down the back of the left thigh and the leg to the foot. A tumour in the left buttock was noted at this time.

Fig. I. X-ray of pelvis.

When the patient arrived in hospital she was bedridden, and lay with her left hip flexed. On obliteration of the lordosis by full flexion of the right hip joint, the left hip was noted to be flexed sixty degrees and adducted twenty degrees. The hip could only be moved through a range of ten degrees in any direction, and movements were very painful. A stony hard mass was visible and palpable in the lower half of the left buttock and the upper part of the left thigh. The tumour apparently arose from the bony pelvis. The iliac crest and the sacrum were of normal size and shape. An X-ray picture showed a diffuse opacity involving the ischio-pubic ramus of the innominate bone (Fig. I). The head and the neck of the femur were visualized through the opacity of the tumour shadow, and noted to be of normal shape and size. Despite the severe pain from which she was suffering, the patient refused the amputation which was proposed for her relief.

On 3rd Dec., 1948, the tumour was exposed at operation, and an attempt was made to excise the tumour piece-meal. A vertical incision was made down the back of the left buttock and the gluteus maximus muscle was divided. The tumour lay deep to this muscle, below the belly of the pyriformis. The sciatic nerve coursed down the outer side of the tumour. The capsule of the tumour was incised, and chondromatous tumour tissue of which it was made was scooped out. This manoeuvre eventually bared the head and neck of the femur which were seen to be normal. The acetabulum was, however, involved in the growth. The attempt to excise the tumour was abandoned at this stage and the wound was closed. The wound healed and the patient left hospital on 15th Jan., 1949, unrelieved of her pain and disability.

She was readmitted to hospital on 7th June, 1950. The tumour had increased in size and the pain was worse (Fig. II). An interinnomino-abdominal amputation was proposed and the patient now consented to the operation. On 23rd June, this operation was done under light percaine spinal anaesthesia supplemented by gas and oxygen. A drip blood transfusion was kept going throughout the operation and continued for four hours after it, three pints of blood being given. A long anterior flap was raised from off the front of the thigh. The tumour was adherent to the skin just below the anterior superior iliac spine of the ilium. The external oblique aponeurosis was split in the direction of its fibres along a line extending from the angle of the superficial inguinal ring. The wound was deepened

by dividing the deeper muscles of the abdominal wall down to the peritoneum. The peritoneum was swept off the iliacus muscle and the walls of the true pelvis. The tumour was bulging into the pelvis, but the pubic bone was not affected. The symphisis pubis was divided. The iliac bone was

Fig. II. Photograph of patient, showing scar of first operation and the position of the tumour in the buttock.

sectioned vertically from its crest to the great sciatic notch just lateral to the sacro iliac joint. The lower limb with the hemi-pelvis was gently swung outwards from off the trunk. The bladder and rectum were now fully bared and the ureter was seen on the peritoneum running to the bladder. The outer ends of the sacro-tuberous ligament and the sacro-spinous ligament were divided, and also the pyriformis muscle. The branches of the internal iliac artery passing out to the buttock were ligated and the hind quarter was removed. The patient stood this extensive operation well. The bladder needed catheterisation for some days after the operation.

On 29th June, the central portion of the long anterior flap was seen to be gangrenous over an area the diameter of the palm of a hand. This area healed by re-epithelialisation after separation of the gangrenous tissue.

The patient left hospital on 26th Oct., 1950, walking with the aid of crutches. She was asked to report back for fitting of a prosthesis.

Histological examination of the tumour showed the structure of a chondroma. The tumour extended from the ischio-pubic ramus below up on to the dorsum ilii and the iliac fossa. The adherence of the skin flap to the tumour suggested that the tumour was becoming malignant but no histological evidence for this was detected.

REFERENCES.

BILLROTH, T. Quoted by Savariaud. (1902). *Rev. Chir.*, vol. 26, page 345.

GORDON-TAYLOR, Sir G. and WILES, P. (1935), *Brit. J. Surg.*, vol. 22, page 571.

GORDON-TAYLOR, Sir G. (1940), *Brit. J. Surg.*, vol. 27, page 643.

SEMINOMA IN THE ECTOPIC TESTIS.

By V. S. HOWARTH.

Newcastle.

ODIORNE and Simmonds (1904) pointed out that there should be a distinction drawn between the terms "undescended testicle," by which is meant one which has been arrested at some point in its normal course of descent, and the "imperfectly descended testicle," which includes the above class as well as the various forms of ectopia. The term "ectopia of the testicle" should be used to designate a mal-position of an organ, which in its descent has deviated from its normal course.

FIG. I. The testicle removed at operation. Note that the tunica vaginalis has been folded back to show the testis. Tunica vaginalis contained about 20 ccs. of clear serous fluid. The surface of the testicle is covered by dilated vessels and shows irregular lobulation.

Dennis Browne (1938) describes the superficial inguinal pouch, a space filled with the loosest of areolar tissue, lying superficial to the external oblique muscle of the abdomen and bounded superficially by the fascia of Scarpa. He states that a testis which lies in the superficial inguinal pouch is definitely an ectopic one. To arrive in the superficial inguinal pouch, the testis has turned sharply upwards and outwards on leaving the external abdominal ring, apparently because of an abnormal attachment of the fascia of Scarpa to the pubic bone.

Campbell (1942) in a statistical review of the incidence of tumour formation in the ectopic testis, stated that he could not find a report of a case in which a malignant growth in an inguinal testis was described as being superficial to the external oblique muscle, but he admits that undoubtedly such cases have occurred and it would seem that the surgeon could easily distinguish whether the external oblique muscle lay over or below the tumour, but so far as he knows, this detail has not been published in the papers on malignant change in the inguinal testis.

The following report records the occurrence of a seminoma in a testicle located in the right superficial inguinal pouch.

An unmarried male, aged 52, complained of frequency of micturition as his only symptom. General physical examination failed to reveal any abnormality. Examination of the patient's genitalia disclosed that the penis was infantile and that the right side of the scrotum did not contain a testis and this side of the scrotum was small and undeveloped. The left testicle was small and atrophied. A lump was apparent in the right inguinal region, about 2 inches above and lateral to the pubic spine. This lump was hard, lobulated and about the size of a small orange. It was freely mobile and appeared to be situated within the inguinal canal. It was not tender and the patient stated that six months previously this lump had been situated at the neck of the scrotum, but had retracted to its present position following an injury. He also stated that he had not noticed at any time an increase in the size of this lump, which had not worried him in any way and he did not complain of its presence as a presenting symptom. Two years previously, the patient had consulted his own doctor and had been advised that right orchidectomy should be carried out on account of the position of the right testicle. This advice had been declined. Rectal examination disclosed that the

prostate was small and firm, but not tender. Examination of the patient's urine showed that 2 to 10 pus cells per high powered field were present and on culture the urine yielded a growth of bacillus coli. The blood serum acid phosphatase was 3.2 King Armstrong units. The Ascheim-Zondek reaction performed on the patient's urine gave a negative result. An intravenous pyelogram showed normally situated and functioning kidneys and cystoscopic examination disclosed a normal bladder and bladder neck.

FIG. II. The cut surface of the testis. Note that the testicular structure has been completely replaced by new growth which has erupted through the tunica albuginea and has invaded the substance of the epididymis. Sections have been taken for microscopy from the upper pole of the tumour.

Right orchidectomy was performed. The testicle was found to be lying deep to the fascia of Scarpa and superficial to the external oblique aponeurosis, about 2 inches above and external to the right external abdominal ring. The spermatic cord ran downwards and medially to enter the external abdominal ring and the veins of the right pampiniform plexus were grossly enlarged. The cord was ligated and divided with a diathermy scalpel.

The specimen removed is illustrated in Figs. I and II and the microscopic appearance of the tumour is shown in Fig III. The patient's convalescence from operation was uneventful and, on his discharge from hospital, he was given a course of deep X-ray therapy to the abdominal lymph nodes.
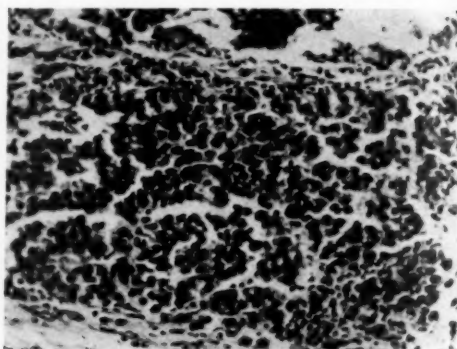

FIG. III. A photomicrograph of the tumour (x 200). The tumour is of uniform structure and is a seminoma. Note the small round cell shown in the section toward the periphery of the growth. In some parts of the tumour these lymphocytes showed indefinite follicle formation.

The cause of the patient's frequency of micturition, his sole complaint, was attributed to chronic prostatitis which was treated by a course of prostatic massage and Penicillin therapy with some relief.

SUMMARY.

1. A case of seminoma occurring in an ectopic testis is reported.

2. The testis was situated in the right superficial inguinal pouch.

ACKNOWLEDGEMENTS.

REFERENCES.

BROWNE, D. (1938), Brit. Med. J., vol. 2, page 168.
CAMPBELL, H. E. (1942), Arch. Surg., vol. 44, page 353.
ODIORNE, W. D. and SIMMONDS, C. C. (1904), Ann. Surg., vol. 40, page 962.

Books Reviewed.

THE PRINCIPLES OF ANATOMY.

By A. A. ABBIE, M.D., B.S.(Syd.), D.Sc.(Syd. and Adel.), Ph.D.(Lond), Elder Professor of Anatomy and Histology in the University of Adelaide. Third Edition. Sydney: Angus & Robertson, 1950. 8½" x 5½", x plus 301 pp., 81 illustrations. Price: 25s.

The appearance of a new edition of Professor Abbie's most interesting introduction to the study of anatomy is welcomed. The fact that three editions and one reprinting have been called for since 1940 is an indication of its popularity.

The new edition has been revised, some chapters rewritten and enlarged and two new chapters and a few illustrations added. All this has improved the value of the book from the student's point of view. It is a matter of some regret that the price of the book has doubled since the last edition came out in 1946.

GYNAECOLOGY.

By HERBERT H. SCHLINK, M.B., Ch.M.(Sydney), F.R.A.C.S., F.R.G.S.; CLEMENT L. CHAPMAN, D.S.O., V.D., Med. des Epid., M.B., Ch.M.(Sydney), F.R.C.S. (Eng.), F.R.C.S.(Edin.), F.R.A.C.S.; GEORGE G. L. STENING, M.E.D., M.B., B.S.(Sydney), F.R.C.S.(Edin.), F.R.A.C.S., M.R.C.O.G.(Eng.); FREDERICK N. CHEN-HALL, M.B., B.S.(Sydney), F.R.C.S.(Eng.), M.R.C.P. (Ireland), F.R.A.C.S. Second Revised Edition. Sydney and London: Angus & Robertson Ltd., 1949. 8½" x 5½", 650 pp., 198 figures. Price: 67s. 6d.

This book has very many merits for the student and for the practitioner. It does not pretend to be a textbook for the specialist. The chapter on anatomy of the pelvis is very well described. Especially is this so in regard to the uterine supports and the description of fascia and ligaments, and there are such excellent illustrations. Students, practitioners and specialists would do well to read the anatomy of the supports carefully. The lymphatic supply is quite adequate, but the pelvic blood supply does not appear to be as full as it could be, nor as clear as the other parts of the chapter. Gynaecological physiology is a valuable contribution, especially in regard to the endocrines and menstruation. The chapters on disorders of function and sterility give concise discussions of these conditions.

The chapters on specific infections and localised inflammation are concise, and provide information on those subjects in a well arranged manner. Injuries, prolapse and displacements are dealt with most satisfactorily.

Tumours and new growths and malignant growths are given very full value, and both by description and illustration these subjects received the attention which they merit and which textbooks often tend to overlook.

The student would be wise to read and understand the chapter on "Examination of the Patient."

The chapter on operative gynaecology, which again is illustrated very well, gives the general practitioner all the information that he should require for gynaecological surgery.

The Schlink cervical enucleator is very fully described together with its advantages in preserving the vaginal vault.

This book has been published with meticulous detail for the practitioner and the student, and is very comprehensive and well illustrated.

The chapters on malignancy have been given very concisely and they cover all the ranges of gynaecological involvement.

The work is exceptionally good, well described and illustrated.

RECENT ADVANCES IN OCULAR PROSTHESIS.

By J. H. PRINCE, F.B.O.A., F.S.M.C., F.R.M.S., F.Z.S. (Edin.). Edinburgh: E. & S. Livingstone Ltd., 1950. 8¾" x 5½", viii plus 155 pp., 89 figures. Price 20s. sterling.

This volume forms a supplement to the author's previous book — "Ocular Prosthesis" (1946), the presence of which is required for reference. The present publication has been more carefully written than the previous book and the discussions have been better controlled.

The first chapter describes the materials and techniques for making impressions of conjunctival sockets. Then follows descriptions and illustrations of the recent globe implants, with the appropriate operative procedures. Information concerning the possibility of extrusion is insufficiently recent as only Cutler's opinions up to January, 1947 are given. Mr. Prince is convincing when he writes of manufacturing techniques but is obviously uncomfortable when describing surgical aspects. This chapter is the one of most direct interest to ophthalmologists as most of the different implants are described, but in future editions it could be improved by being written by an ophthalmic surgeon interested in prostheses.

One chapter is used to illustrate some difficult cases improved by skilled fitting. Plastic surgery is but briefly mentioned. Orbital prostheses are described but are worthy of illustrations.

The final chapters describe improved manufacturing methods for plastic artificial eyes, emphasis being on individual treatment.

There is undoubtedly a need for books such as Mr. Prince has written and a later edition should combine the useful material from each. However, he cannot write with confidence on some of the subjects he has now included. Collaboration is probably required to make the book appeal to the surgeon as well as the prosthesthetist.

THE CLOSED TREATMENT OF COMMON FRACTURES.

By JOHN CHARNLEY, B.Sc., M.B., F.R.C.S. Edinburgh: E. & S. Livingstone Ltd., 1950. 6¾" x 9¾", xi plus 190 pp., 133 figures. Price: 35s. net.

Mr. Charnley has been inspired to write this monograph to defend the closed method of treatment of fractures. During a recent visit he found in North America that surgical practice was turning more and more to open reduction as a primary method of treatment. Current surgical literature supports this view.

He is a most able advocate for the closed method of treatment and has shown convincingly that "far from being a crude and uncertain art, the manipulative treatment of common fractures can be resolved into something of a science." However, he is not bigoted in his outlook and recognises the necessity for operation in certain instances.

The manipulative art for reduction of fractures is as old as surgery itself, though it is doubtful whether it has been given proper emphasis in the surgical teaching of students.

He has discussed the mechanics of deformity in fractures and endeavoured to put these on a sound basis with the result that the subsequent reduction is a rational and precise procedure.

Concerning the causes and prevention of stiffness in joints following fractures, the author has original ideas which are a further plea for closed methods of treatment especially in femoral shaft fractures. The necessity for surgeons undertaking fracture work to master plaster technique has been rightly stressed. There is an excellent critical study of the various plaster methods.

Each of the common fractures is dealt with in orderly sequence. It is refreshing to find a modern surgeon advocating and paying tribute to the use of the Thomas splint for femoral shaft fractures. The book is excellently produced with good diagrams and illustrations and in every way is a credit to British surgery.

The monograph is primarily written for the resident casualty surgeon, but should be carefully read by those whose duty it is to teach students. There is much in this book that will cause the experienced orthopaedic surgeon to review critically many established procedures.

THE PHYSIOLOGICAL BASIS OF MEDICAL PRACTICE.
A Text in Applied Physiology.

By CHARLES HERBERT BEST, C.B.E., M.A., M.D., D.Sc.(London), F.R.S., F.R.C.P.(Canada), and NORMAN BURKE TAYLOR, V.D., M.D., F.R.S.(Canada), F.R.C.S. (Edin.), F.R.C.P.(Canada), M.R.C.S.(Eng.), L.R.C.P. (Lond.). Fifth Edition. Baltimore, U.S.A.: The Williams & Wilkins Company, 1950. 6¾" x 10", xiii plus 1,330 pp., 601 illustrations, 95 tables. Price: £5 18s. 3d.

(Sent by Angus & Robertson Ltd., Sydney.)

"The Physiological Basis of Medical Practice" by Best and Taylor has now appeared in its fifth edition. This book is both well known and widely respected in Australia, and the new edition is of the usual standard and pattern. However, revaluation of the Australian currency and the addition of one hundred pages to the book have made both the price and the weight of the new volume just short of six pounds.

The authors state that the whole book has been revised and reset, and there is ample evidence of this. Almost every chapter contains new material and new figures are both numerous and of a high standard. The index is a particularly pleasing feature of this volume which adds greatly to its value as a book of reference. However, the references and the spelling have a predominantly American flavour which is sometimes a little unpalatable.

It would be unfair to single out any one section of Best and Taylor for criticism, because the authors have plainly striven to make the new volume up to date. Deletions from the material of the previous volume are numerous, but so too are the additions to the new volume. While these latter are presented faithfully, for the most part they are left entirely without criticism. The well established material which has stood the test of time is presented alongside the controversial, and the student gets little indication of which parts may be omitted when the next volume is produced. This has always appeared a serious fault in Best and Taylor so far as the present reviewer is concerned, and one which renders the book suitable mainly for reference. In this field he has always found it pre-eminent, and expects the latest edition to prove no less valuable than the earlier ones.

TUMOURS OF THE HEAD AND NECK.

By GRANT E. WARD, M.D., F.A.C.S., and JAMES W. HENDRICK, M.D., M.S. Baltimore, U.S.A.: The Williams & Wilkins Co., 1950. 7" x 10", xv plus 832 pp., 637 illustrations, 46 tables. Price: £8 1s. 9d. (Sent by Angus & Robertson Ltd., Sydney.)

While the term tumour, as used by the authors of this work, is to be taken in its very widest sense, a great part of the matter is inevitably concerned with regional malignancies, actual or potential.

It is evident that the authors, from their sound training, wide experience and familiarity with the problems of treatment, are entitled to speak with the voice of authority and to command an attentive audience. The senior author, Grant E. Ward, a fellow student of Blalock, who contributes a foreword, was earlier closely associated with Howard Kelly in the development of electro-surgery as an adjunct to straight surgery and of the ancillary methods of treatment by X-rays and radium. The junior author, James W. Hendrick, a former Fellow in Surgery under von Eiselberg, confines his work to surgery with special reference to the neck and to cancer problems in general.

A preface sets out the scope and aims of the volume and in it occurs the following—

"Far too often the surgeon or radiologist views the patient and his malady in the light of his own training and experience without adequate information of the value of the other's therapy and without recognising the limitations of his own field. We have compared both methods of treatment and suggested our choice based on years of experience in surgery and radiation therapy."

There are few who would deny the need for such a judicial approach.

An introductory chapter deals with the general principles of treatment by surgery, electro-surgery and radiation, and the tissue changes associated with the two latter, particularly post-radiation reactions.

Since a knowledge of the development of the head and neck is important to the surgeon the second chapter deals with this in some detail. It is well illustrated and followed by an excellent bibliography. Both these features are notable throughout the book and constitute a most valuable addition to it.

From time to time every surgeon is confronted with the problem of a questionable malignancy in mole or naevus, whether pigmented or unpigmented, and nearly 100 pages are devoted to a very well illustrated description of such tumours, their origin, their histo-pathology and the treatment appropriate to these "biological outlaws." Included within the pages upon malignant and premalignant skin lesions are even such conditions as haemangioma, lymphangioma, dermoids, sebaceous cysts and keloids; upon the treatment of this last, helpful advice is given. Full consideration is given to the treatment of frank malignancies of nose, ear and eyelids, and of malignant melanoma wherever occurring, which, according to the authors, should be entirely treated by very radical surgery.

More than 100 pages are devoted to cancer of lips, tongue and oral cavity. In the lip, surgery is favoured and a modification of the useful Abbé-Estlander procedure for the closure of large defects is described and illustrated, as well as numerous other plastic methods. They describe, too, a useful sign in determining bone (mandibular) involvement via the meatal foramen (3.4% of their cases). Radiation is reserved for growths under 1.5 c.m. in diameter and only in the elderly is it used in larger growths. The use of radium has been discontinued. The treatment of the lymphatic gland area is logically discussed.

In those chapters given to malignancies of the oral cavity, tongue and floor of the mouth it is made plain that there is no standard plan of attack, but that the choice made between surgery and irradiation is entirely dependent upon the varying conditions met with in practice. Often a combination of methods is favoured—radiation preceding surgery, in which one of the electro-surgical methods may be used. In some cases of carcinoma of the tongue a pull-through type of operation is practised so that a true block resection in the Halstead tradition can be carried out. The authors' attitude towards the lymphatic area is a very radical one, and the whole presentation is one of great interest to radiotherapist and surgeon alike.

Some 80 pages are given up to tumours of the jaws, covering the radiological characteristics, pathology and treatment of these often confusing conditions, of which the authors appear to have had an exceptional experience.

The chapter upon salivary gland tumours is based upon an equally large series — 142 cases, including 18 of aberrant tissue tumours. Treatment is surgical, as such growths are not radiosensitive.

A good description is given of naso-pharyngeal and pharyngeal tumours and their treatment, but with the possible exception of this subject the other contributed papers, totalling nearly 200 pages, and dealing with tumours of the paranasal sinuses and those of the ear, larynx and eye and its adnexae, are of more particular interest to those specialising in these fields.

In the chapters dealing with those tumours occurring in the neck a most comprehensive account is given of the various cysts and fistulae found here, of bronchogenic carcinoma, and of tumours of the carotid body.

The difficult and confusing subject of carcinoma of the thyroid is discussed at length, particularly its relationship to discrete adenomata, and a series of 112 cases reviewed. In suitable cases an extensive operation with temporary tracheotomy is practised. The utility of radio-active iodine in the treatment of the more highly differentiated malignancies is discussed, as is the method of administration and the safeguards necessary in its employment.

An excellent description is given of para-thyroid tumours, their pathology and the difficulties associated with their diagnosis and treatment.

Worthy of note is a chapter upon the pathological and radiological diagnosis of both primary and metastatic tumours of the skull.

A final chapter on rehabilitation deals with the problems met by the plastic surgeon in his repair of the defects and deficiencies often produced by radical surgery in the head and neck, both of soft parts and of bone. In this latter the co-operation of a skilled dental surgeon is essential.

As a work of reference and source of bibliography this volume is to be highly commended.

THE LIVER—PORTA MALORUM (THE GATEWAY TO DISEASE).
By KASPAR BLOND, L.R.C.P., L.R.C.S.(Edin.), L.R.F.P.S.(Glasgow), M.D.(Vienna), and DAVID HALER, M.B., D.C.P.(Lond.). Bristol: John Wright and Sons Ltd., 1950. 5½" x 8¼", vii plus 268 pp., 36 illustrations. Price: 25s.

In their book "The Liver—Porta Malorum (The Gateway to Disease)," Blond and Haler have given much thought to the liver and gall bladder and their possible relationship to diseases elsewhere in the body. To the mature worker in experimental surgery the book may be of some interest as it will provide him with food for thought and may cause him to reconsider some of his fixed convictions. However, to the general surgeon this work is of little value, nor can it be recommended as a reference book for students. Many of the opinions expressed by Blond and Haler are in direct conflict with the accepted teachings in Australia. Thus they claim that the gall bladder's function is to absorb bile and it rarely discharges its contents into the common bile duct. They also maintain that when a stone is impacted in the common bile duct jaundice may be minimal if the gall bladder be normal, as it can absorb the bile as rapidly as it is secreted by the liver. They are much concerned about the toxic effects of the various substances used for cholecystography and consider that the results are misleading as the opaque substances cause inflammation of the gall bladder.

The Australian surgeon will consider Blond and Haler's treatment of gallstones to be far too conservative. The authors are confident that most stones are passed happily into the duodenum and they are not greatly concerned about the complications which may ensue from obstruction of the common duct or from acute cholecystitis. They appear to be more impressed by the complications which may ensue after cholecystectomy.

When the authors pass on to diseases of the liver itself, one is surprised to find that virus infection is not mentioned in the section on "catarrhal jaundice or acute hepatitis," nor in a

subsequent section, "icterus gravis." Later, they discuss the part played by the liver in angina pectoris and we read that "portal back pressure is one of the main causes of angina pectoris" (page 157). This idea will not appeal to the modern cardiologist.

The publishers are to be congratulated on the quality of production and some of the coloured illustrations are excellent.

A SYNOPSIS OF SURGICAL ANATOMY.

By ALEXANDER LEE McGREGOR, M.Ch.(Edin.), F.R.C.S.(Eng.).   Foreword by Sir Harold J. Stiles, K.B.E., F.R.C.S.(Edin.).   Seventh Edition. Bristol: John Wright and Sons Ltd., 1950. 4¾" x 7½", 792 pp., 746 illustrations. Price: 25s.

The seventh edition of Mr. Lee McGregor's book maintains the high standard of the previous editions and the volume should find a place on the shelves of all medical libraries.

EYE SURGERY.

By H. B. STALLARD, M.B.E., M.D.(Cantab.), F.R.C.S. (Eng.)   Second Edition. Bristol: John Wright and Sons, 1950. 5½" x 8½", xvi plus 667 pp., 550 illustrations . Price: 52s. 6d.

Although H. B. Stallard's "Eye Surgery" was written during the war under difficult circumstances it was a remarkable book which was received with enthusiasm everywhere by ophthalmic surgeons.

The second edition is much larger, is brought up to date in every way and contains two hundred and twelve new illustrations.

In the preface the author states that his excuse for doing all the drawings and diagrams himself is that he enjoys the work and believes it to be good training for surgical hands. This, no doubt, is very true but he need make no apology for his drawings because the excellent illustrations are the best feature of this most interesting and instructive book. They explain with surgical understanding exactly what the writer means to convey to the reader. The knowledge behind the drawings is apparent and there is no difficulty in following the detailed descriptions of operations.

The book is well planned and the clearly defined sections and headings make it easy to read. Most of the operations described are those which are performed by the author himself but constant reference is made to the technique of other surgeons. Minute details are described, which are interesting to observe, even if the reader may not wish to adopt all of them. The surgical principles are sound and the standard aimed at is one of perfection.

Some of the new features in this edition are the use of fibrinogen and thrombin, cyclodiathermy, amnioplastin, corneal grafting and the use of sterile air. Eyelid reconstruction and plastic surgery occupy a large chapter and while some of these procedures will be beyond the sphere of the average eye surgeon they can be studied with considerable profit as they lead to a wider outlook. Blascovics canthoplasty and ptosis are particularly well illustrated and described. In contrast to these the treatment of symblepharon, which is always difficult, is comparatively rapidly passed over. An operation for pterygium devised by D'Ombrain of Sydney, is well reviewed and clearly described. Surgery of

the iris including occlusion of the pupil and removal of melanoma of the iris is dealt with in a greatly enlarged chapter with excellent diagrams.

Fifty-six pages are devoted to the surgical treatment of cataract and the whole subject is widely discussed from various points of view, including the techniques for intracapsular and extracapsular extractions.

Regarding the incision for cataract the author explains that a number of American surgeons use a broad keratome and scissors because in this way a more even cut is made than with the to and fro movement of a Graefe knife which produces irregularities and raggedness. He states that if the section with the Graefe knife is made with one sweep, the cut is even, but this is not always possible. He does not refer to the T-shaped forceps modified by Aaron Green which holds the eye so firmly that the section with one sweep of the knife can be made with comparative ease.

A new operation for glaucoma which is described as a combined "anterior flap sclerotomy with basal iridencleisis" has been practised by the author with most encouraging results. When he comes to intraocular tumours Stallard writes with authority, because he is one of the pioneers in this field, and his work has given the world new hope. He describes the use of radon seeds in the treatment of intra-ocular neoplasms and his pioneer work and good results are widely recognized. Some criticism might be levelled at the high strength of seeds used and the lack of homogeneity of radiation dosage obtained. He has devised various ingenious appliances in order to reach the posterior parts of the globe with radon seeds and radium. These should be no longer necessary because even the most posterior part of the globe can be reached by tunnelling the episcleral tissue and implanting small radon seeds directly on to the spot required.

Scleral resection for detachment of the retina is made to appear a comparatively simple procedure but the reader is warned that it may be difficult and take up to two hours to perform.

This is a most complete and satisfying book which is interesting and attractive because, throughout the book, the pictures are clear and self explanatory. Ophthalmic surgeons are fortunate indeed, to have this outstanding work of reference and guidance prepared for them by such an eminent surgeon and authority as H. B. Stallard.

Books Received.

ILLUSTRATIONS OF BANDAGING AND FIRST-AID

By LOIS OAKES, S.R.N., D.N. (Leeds and London). Fourth Edition. Edinburgh: E. & S. Livingstone, 1950. 5½" x 8½", vii plus 308 pp., 370 illustrations. Price: 8s. 6d. net.

A SYNOPSIS OF ANAESTHESIA.

By J. ALFRED LEE, M.R.C.S., L.R.C.P., M.M.S.A., D.A., F.F.A., R.C.S. Second Edition. Bristol: John Wright and Sons Ltd., 1950. 4¾" x 7½", 354 pp., 66 illustrations. Price: 15s.

LES PHLÉBITES. Phlébographie clinique et thérapeutique de la Maladie Thrombo-embolique.

By LUCIEN LEGER and CLAUDE FRILEUX. Paris: Masson et Cie, 1950. 6½" x 9½", 300 pp., 85 figures. Price: 1400 fr.